MAGTF Staff Training Program's

Advanced Technical Mobile Training Team

Introduction Agenda

MSTP

- Who are we?
- What are we going to cover?
- Where can you apply this information?
- Why MSTP?

- Rules of the Road

C4I MTT Schedule

MSTP

- Tue (09 July): Advanced MTT Begins
  - OSI Model
  - C2 Systems Overview
  - Communications Architecture/Design
  - Layer 2 (Focused on Switching)
- Wed (10 July):
  - Cisco Switching
  - Cisco Routing (EIGRP/BGP)

C4I MTT Schedule

MSTP

- Thu (11 July):
  - Cisco Routing (EIGRP/BGP)
  - Quality of Service (Focused on Routing)
  - VTC Systems (PolyCom FX/Radvision)
  - Systems/Network Management
- Fri (12 July):
  - Practical Application Exam (Maybe!!!)

Rules of the Road

MSTP

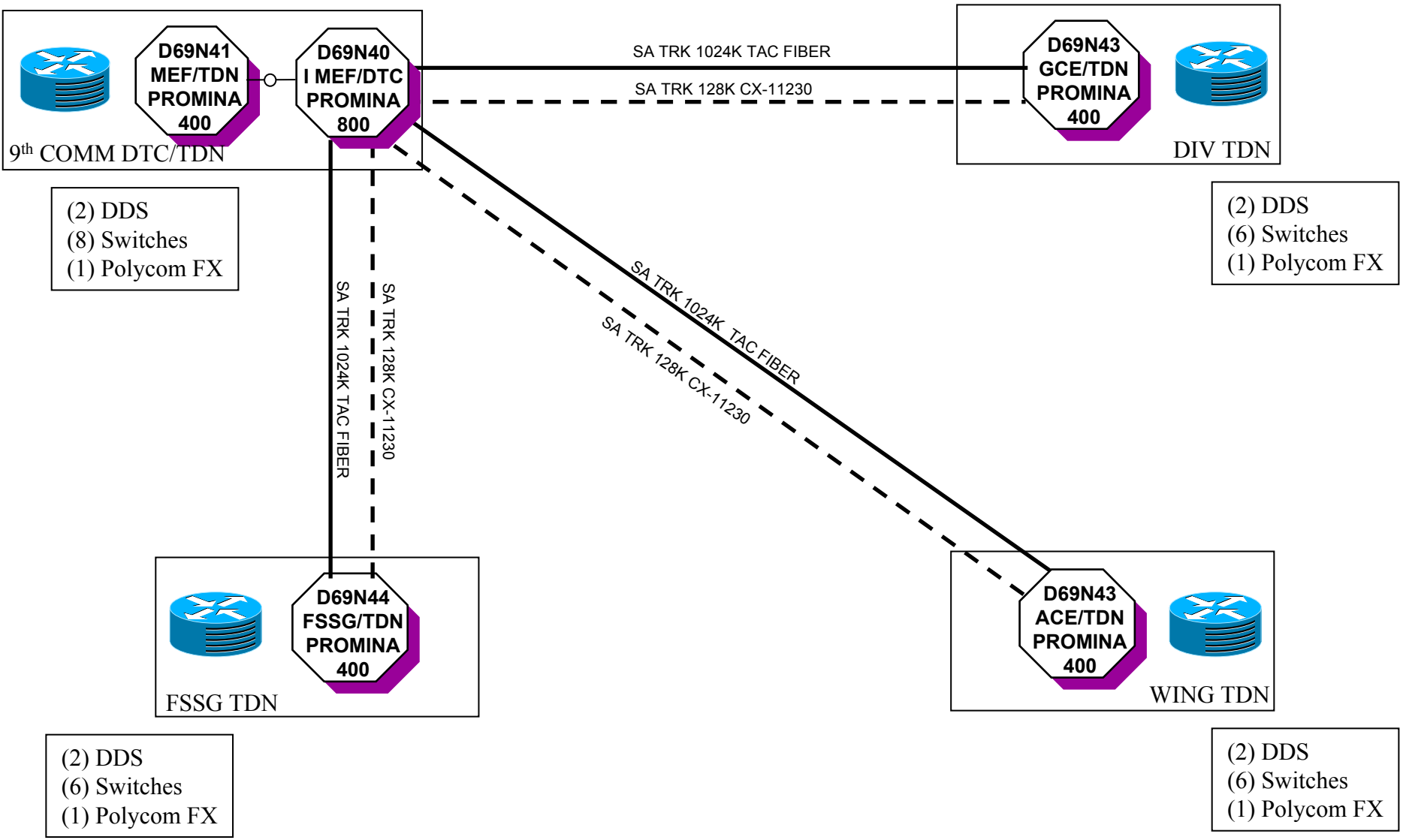
- Security?
- Parking?
- After hours access?
- Smoking areas?
- Drinks and chow in the classroom?

- Instruction?

Introduce yourself!

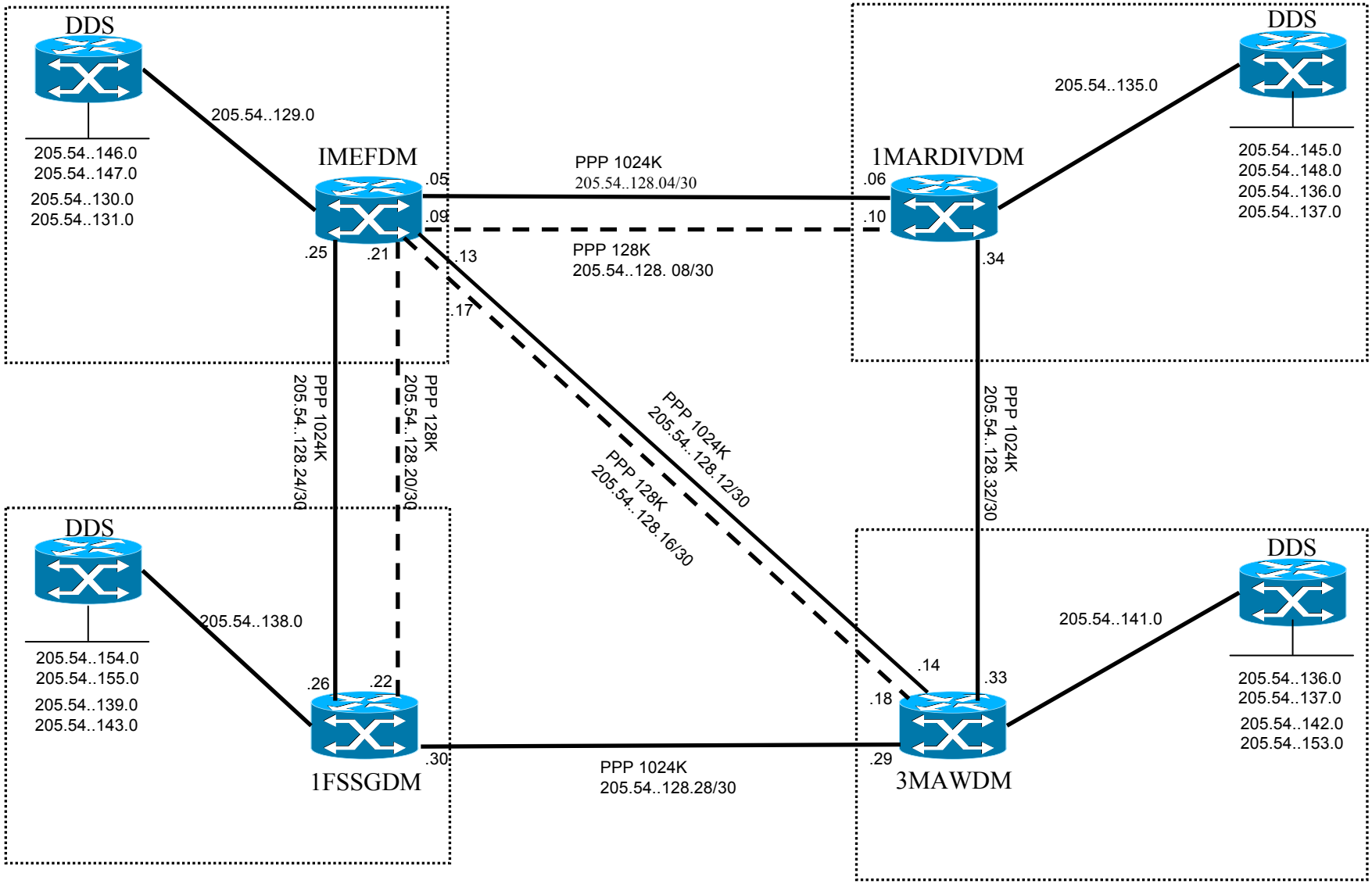
- Name, Rank, and Organization
- Role in supporting Data Communications
- Experience in Data Communications
- Expectations of this training

MSTP Advance MTT Promina Architecture

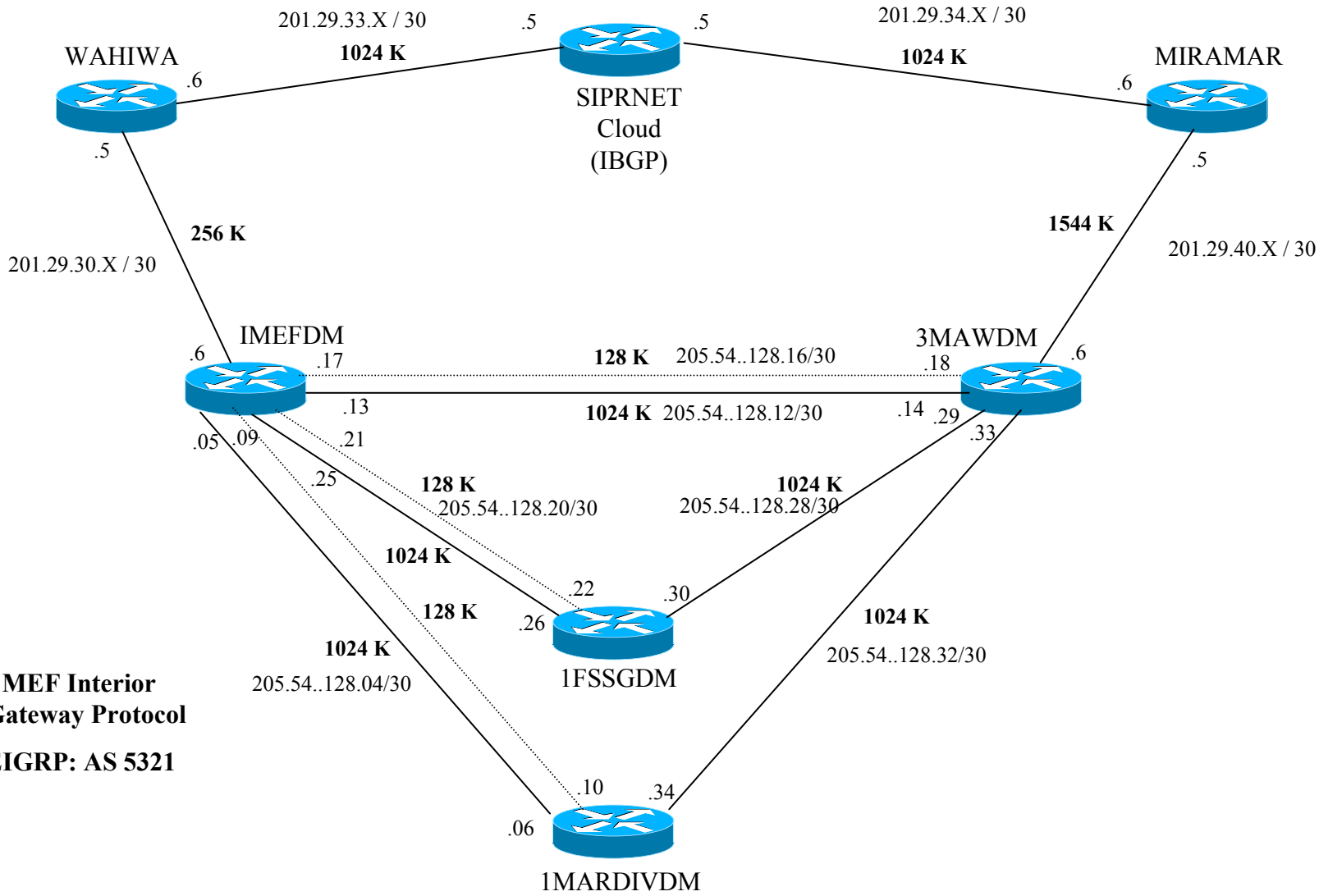


2 Jul 2002

MSTP Advance MTT Router Architecture



Logical Router Diagram, A Different View



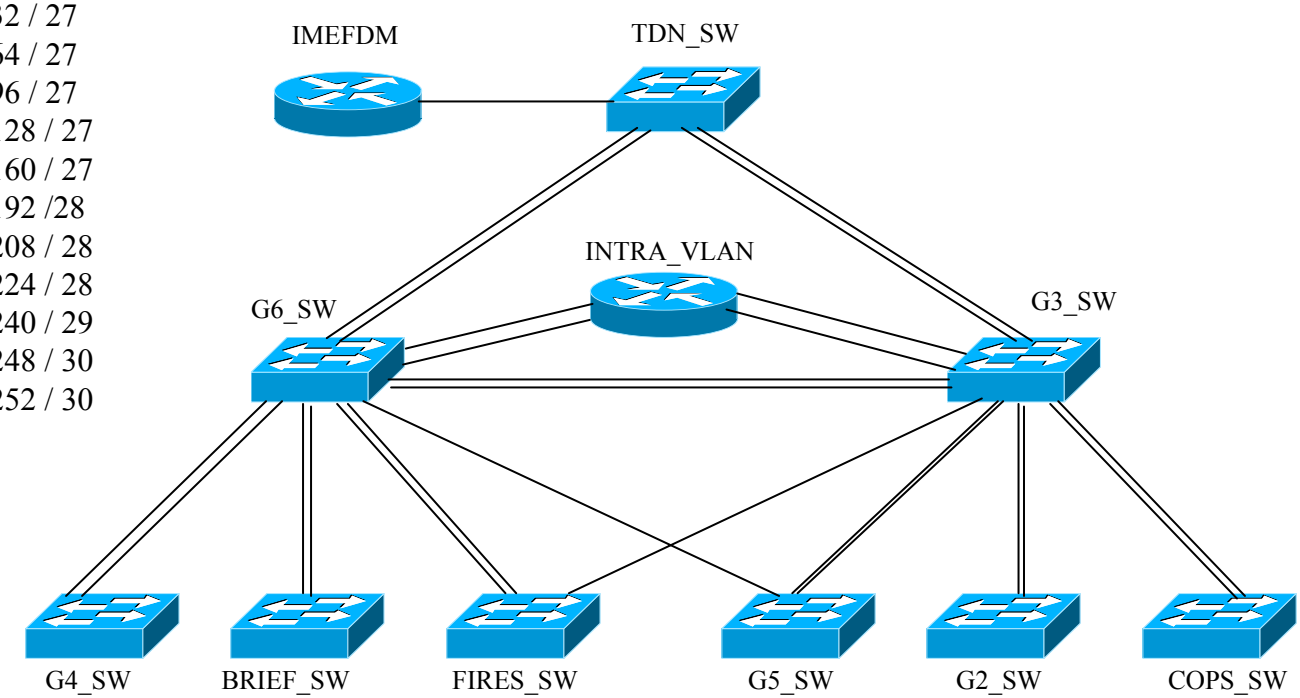
I MEF Interior Gateway Protocol

EIGRP: AS 5321

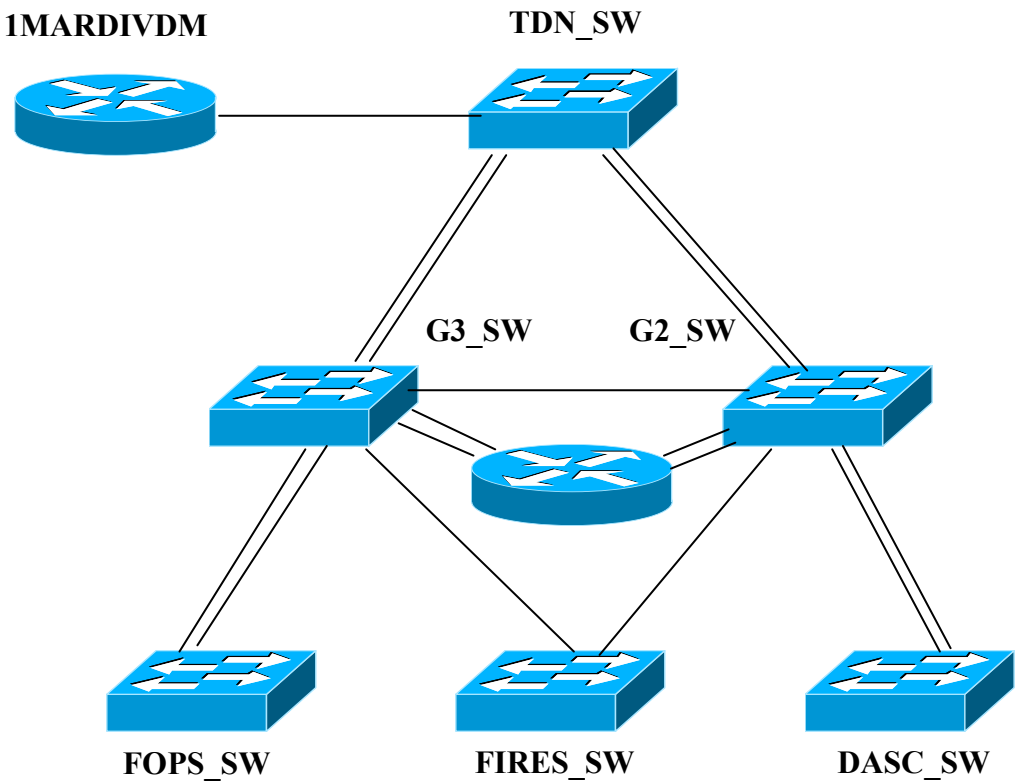
Logical Switch Diagram for IMEFDM

IMEFDM Vlan Assignments:

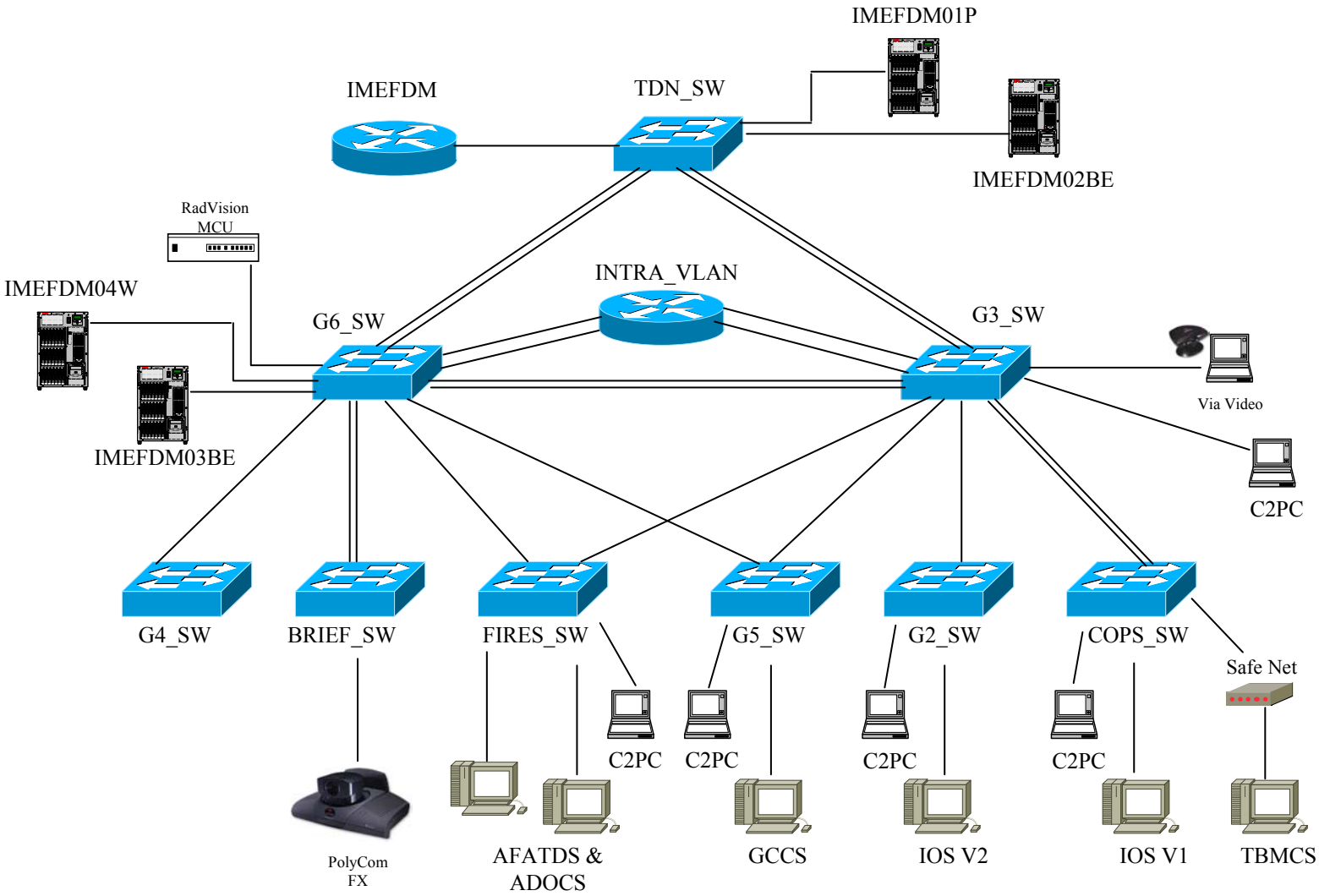
Vlan 2: 205.54.129.0 / 25
Vlan 3: 205.54.129.128 / 26
Vlan 4: 205.54.129.192 / 26
Vlan 88: 205.54.130.0 / 27
Vlan 5: 205.54.130.32 / 27
Vlan 6: 205.54.130.64 / 27
Vlan 7: 205.54.130.96 / 27
Vlan 8: 205.54.130.128 / 27
Vlan 9: 205.54.130.160 / 27
Vlan 10: 205.54.130.192 /28
Vlan 11: 205.54.130.208 / 28
Vlan 12: 205.54.130.224 / 28
Vlan 13: 205.54.130.240 / 29
Vlan 14: 205.54.130.248 / 30
Vlan 15: 205.54.130.252 / 30



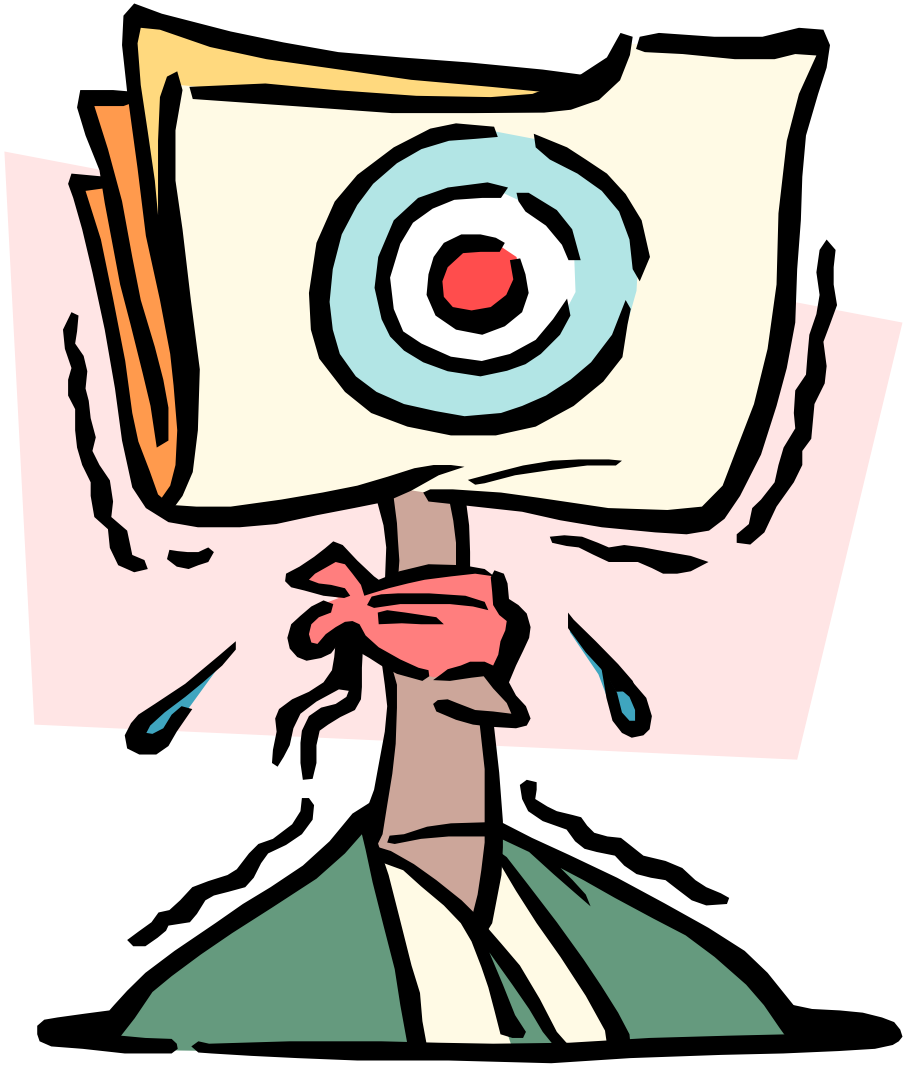
Logical Switch Diagram for Div, Wing, & FSSG



Logical C2 Systems Diagram



Any Questions?



OSI Model & Networking Essentials

Course Outline

- OSI Reference Model
- LAN Segmentation
- IP Addressing and Subnetting

Open Systems Interconnect (OSI)

MSTP

- OSI is a Layered Network Model for networking protocols. Establishes standards for internetworking.
- Clarifies what general functions are to be done rather than how to do it.
- Reduces the complexity of networking into more manageable sub-layers.
- Enables interoperability using standard interfaces (APIs).
- Allows changes in one layer to occur without changing other layers.

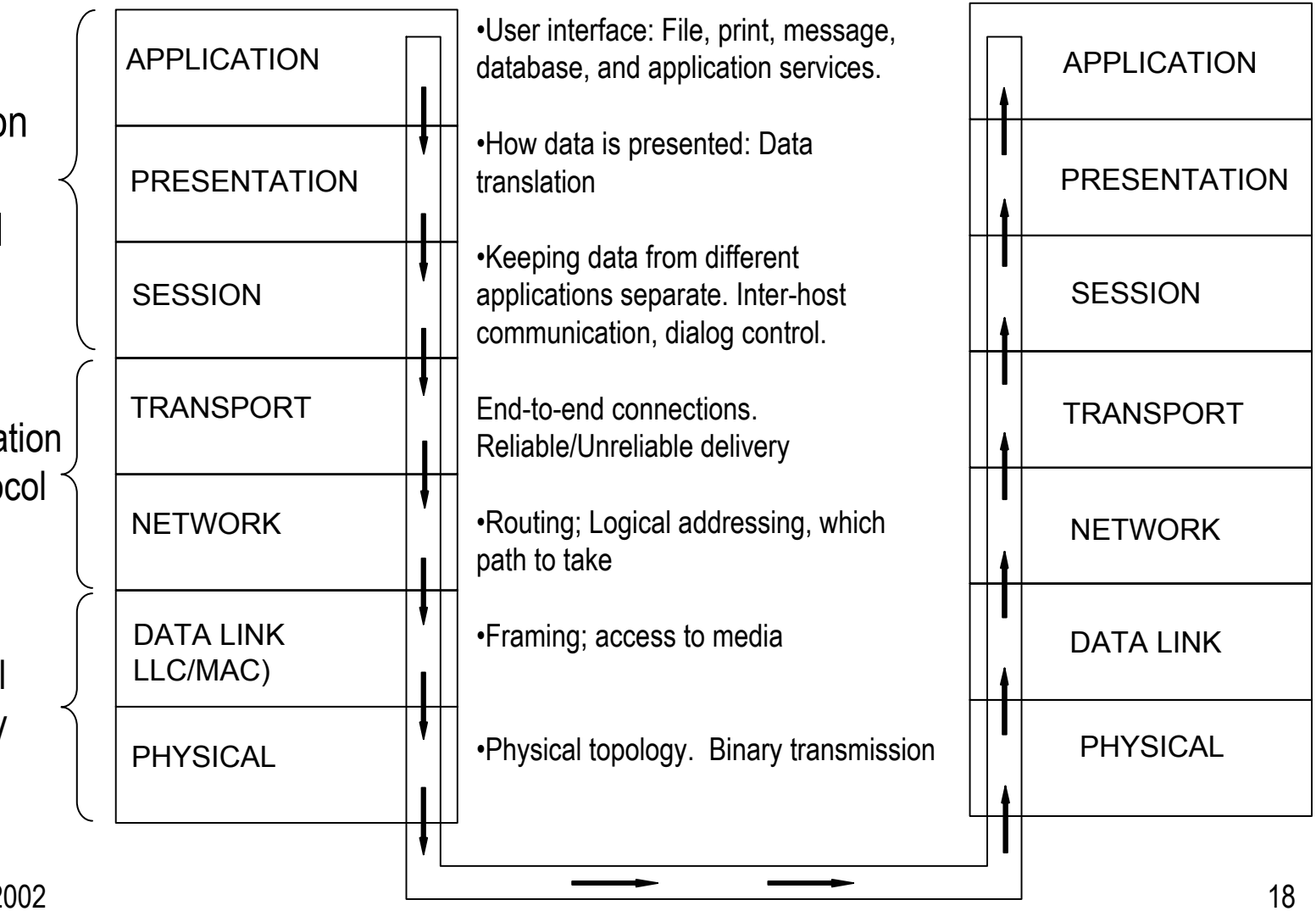
Logical and Physical Data Movement

MSTP

- Logical movement of data
  - Application layer protocol
    - Someone creates information on an application.
  - Communication protocol
    - The information is then packaged for transmission.
  - Transmission protocol
    - The package is now prepared for actual physical transmission.
- Physical movement of data
  - Physical topology
    - The data moves across some type of physical channel.

OSI Protocol Stack

MSTP



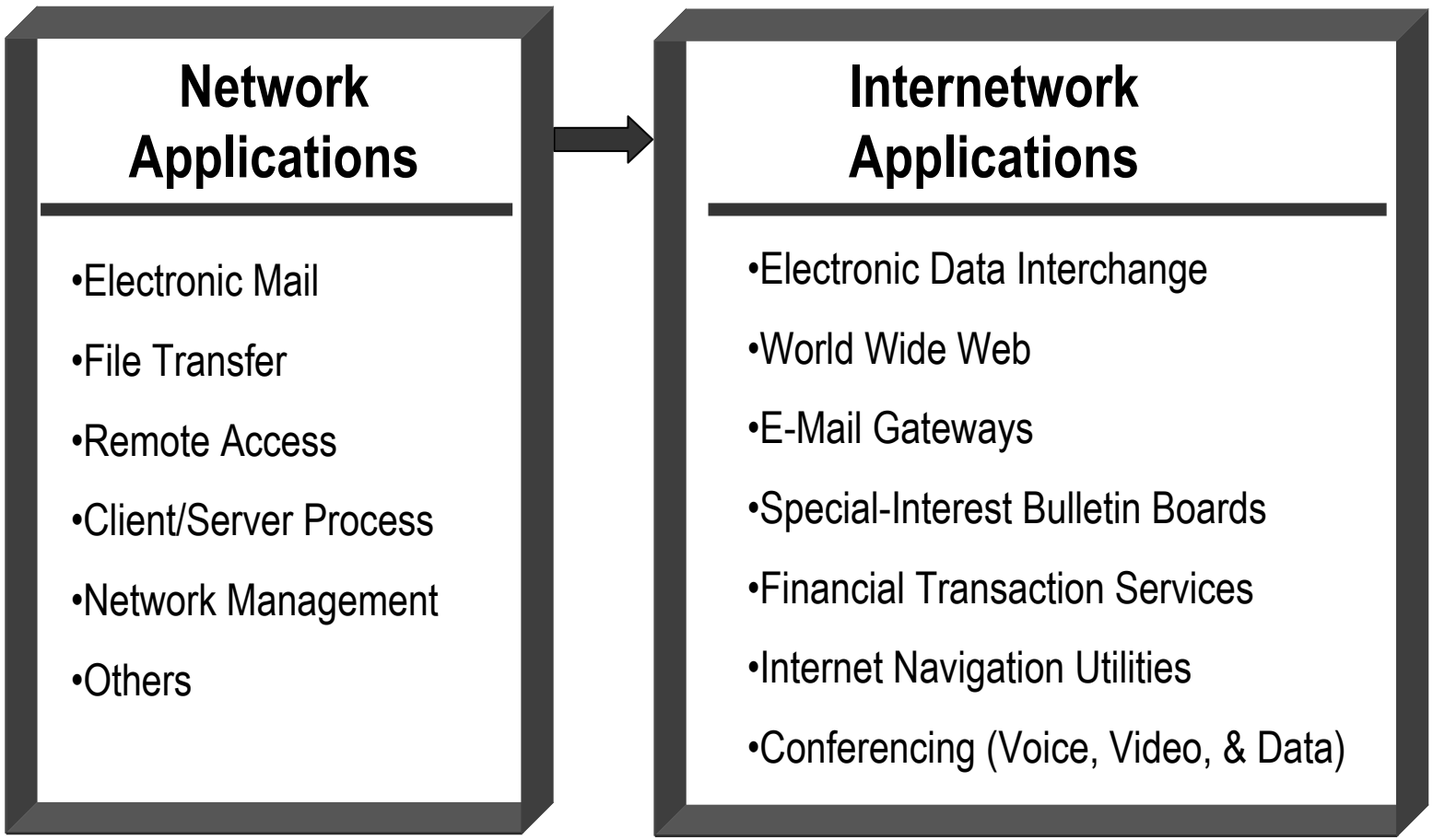
Application Layer

MSTP

- The application layer identifies and establishes the availability of intended communication partners.
- Synchronizes cooperating applications.
- Establishes agreement on procedures for error recovery and control of data integrity.

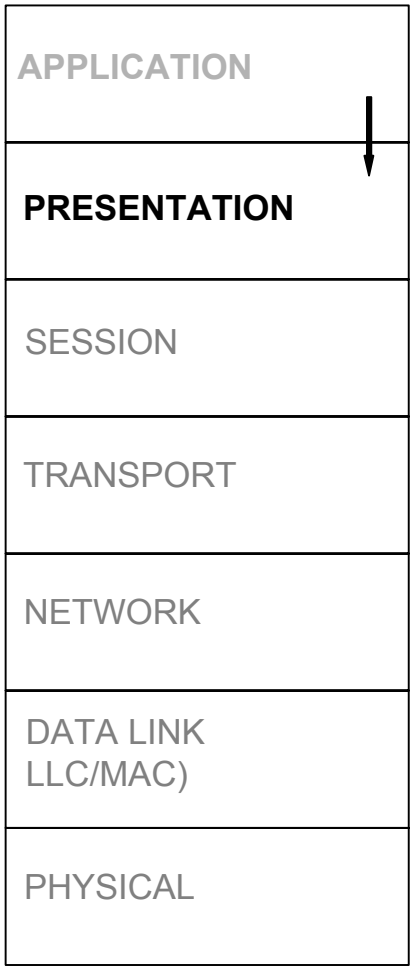
Application Layer cont…

MSTP



Presentation Layer

MSTP



- This layer ensures that information sent by the application layer of one system will be readable by the application layer of another.
  - Data translation
  - Encryption
  - Compression
- Negotiates data transfer syntax for the application layer.

Presentation Layer

MSTP

- Graphics
- Visual Images
  - PICT
  - TIFF
  - JPEG
  - GIF

- Sound
- Video
  - MIDI
  - MPEG
  - QuickTime

- Text
- Data
- ASCII

Captain Cornell

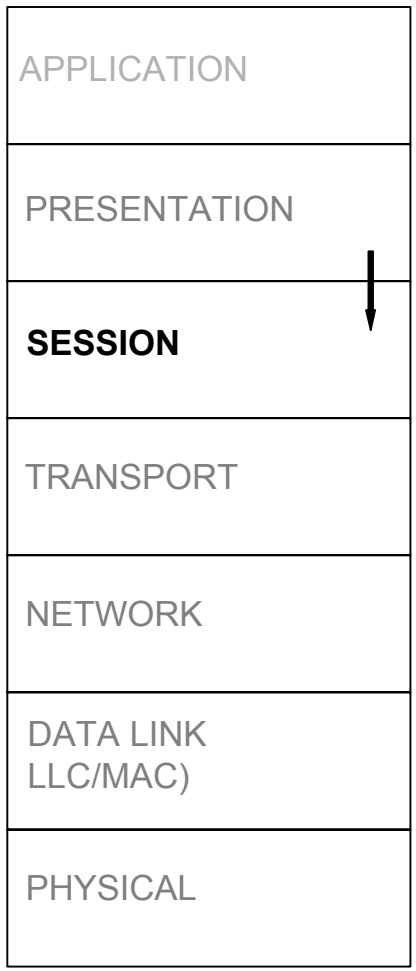
Presentation Layer provides code conversion

Presentation Layer (Cont…)

MSTP

Session Layer

MSTP

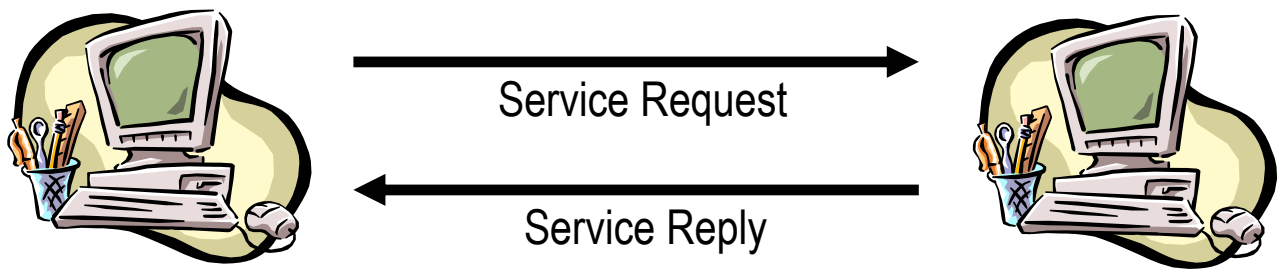


- This layer establishes, manages, and terminates sessions between applications by offering three modes:
  - Simplex (monologue)
  - Half-duplex (forbidden interruption)
  - Full-duplex (flow control issue)
- Accomplished in three phases:
  - Connection establishment
  - Data transfer
  - Connection release
- Manages data exchange between presentation layer and entities.

Session-Layer Protocols and Interfaces

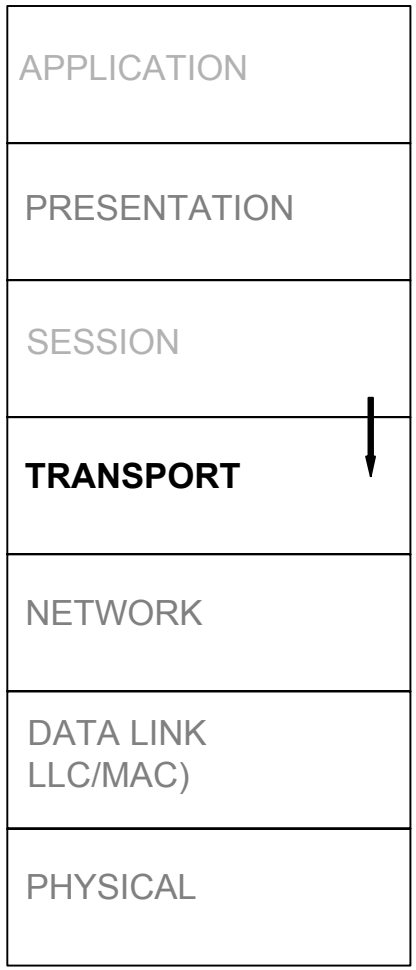
MSTP

- Network File System (NFS)
- Structured Query Language (SQL)
- Remote-Procedure Call (RPC)
- X Window System
- NetBios Names
- Internet Browsers
- DNA Session Control Protocol (SCP)



Transport Layer

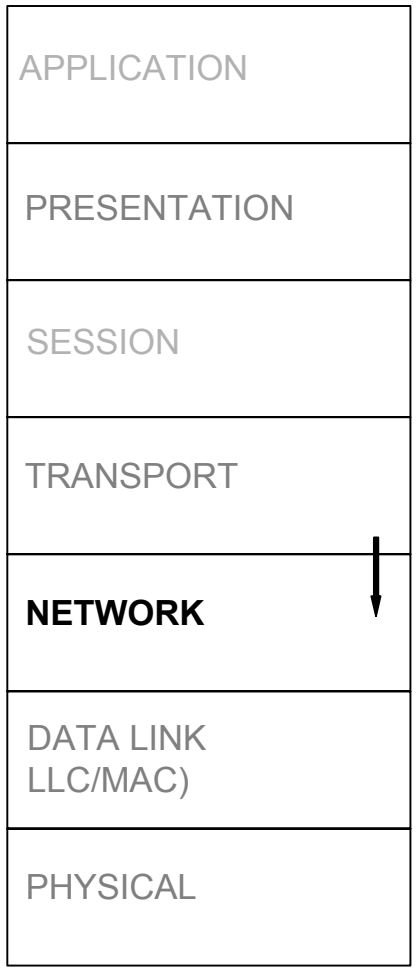
MSTP



- Reliable network communication between end nodes
- Provides mechanisms for the establishment, maintenance, and termination of virtual circuits.
- Transport fault detection and recovery
- Information flow control (buffering,windowing, congestion avoidance)

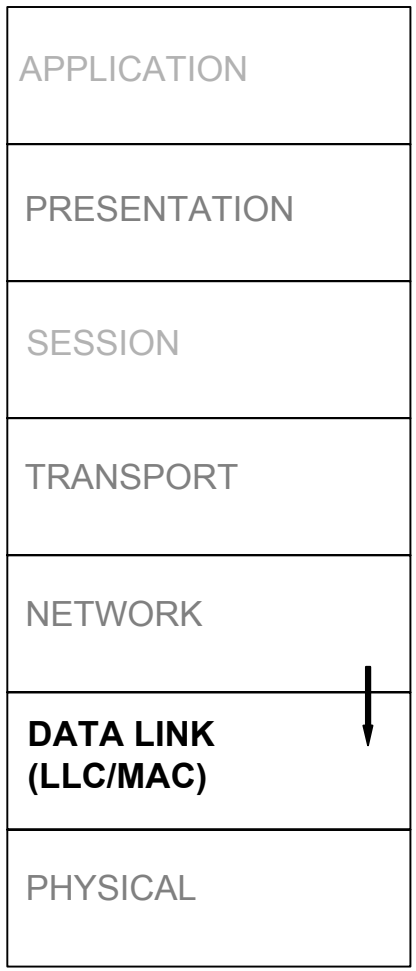
Network Layer

MSTP



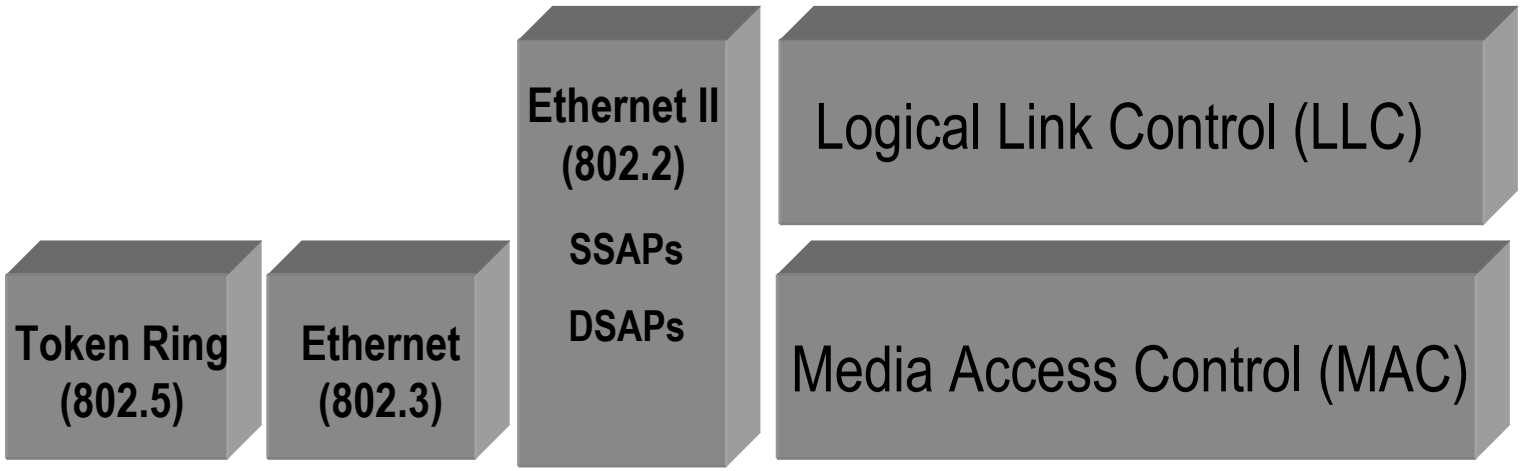
- The network layer is the layer at which routing occurs.
- This layer provides connectivity and path selection between two end systems.

Data Link



- This layer provides reliable transit of data across a physical link.
- Physical addressing (MAC)
- Network topology
- Line discipline (CSMA/CD & CSMA/CA)
- Error notification
- Divided into two sub-layers (MAC and LLC)

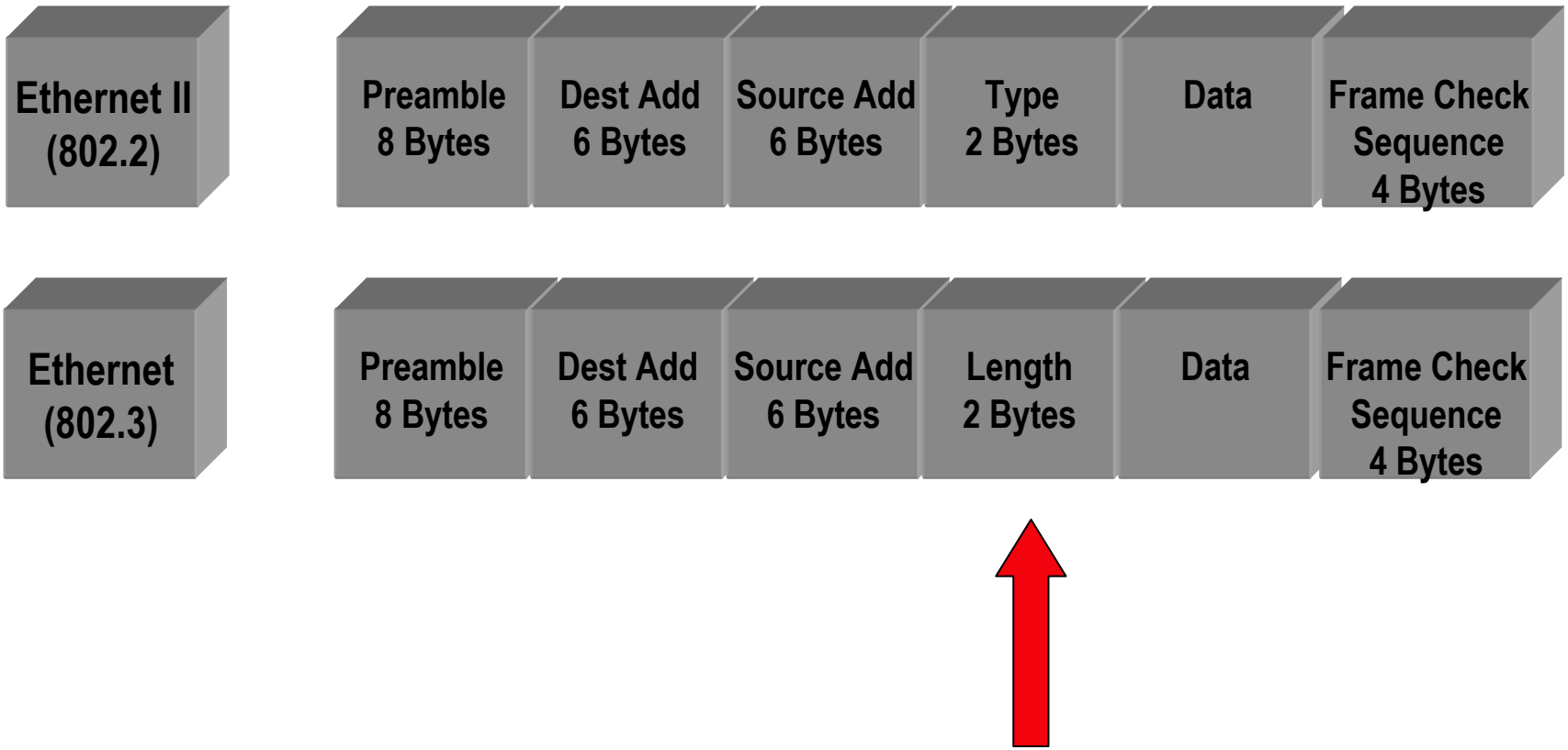
Data Link Sub-Layers



- Logical Link Control acts as the managing buffer
  - Source Service Access Points (SSAPs)
  - Destination Service Access Points (DSAPs)

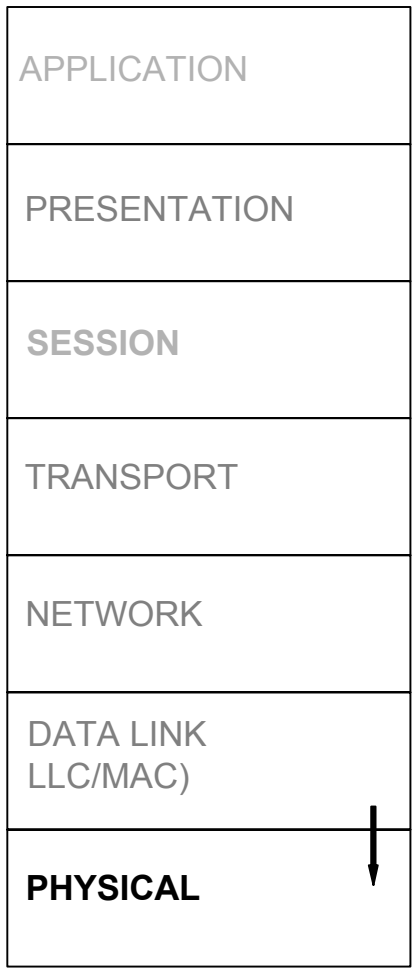
Data Link Sub-Layers

MSTP



Physical Layer

MSTP



- The physical layer defines the electrical, mechanical, procedural and functional specifications for activating, maintaining, and deactivating the physical link between end systems.

Putting it all together …

MSTP

Upper Layer Data

TCP Header | Upper Layer Data

IP Header | Data

LLC Header | Data

MAC Header | Data

0101110101000111010

Application

Presentation

Session

Transport

Network

Data Link

Physical

Protocol Data Unit

Segment

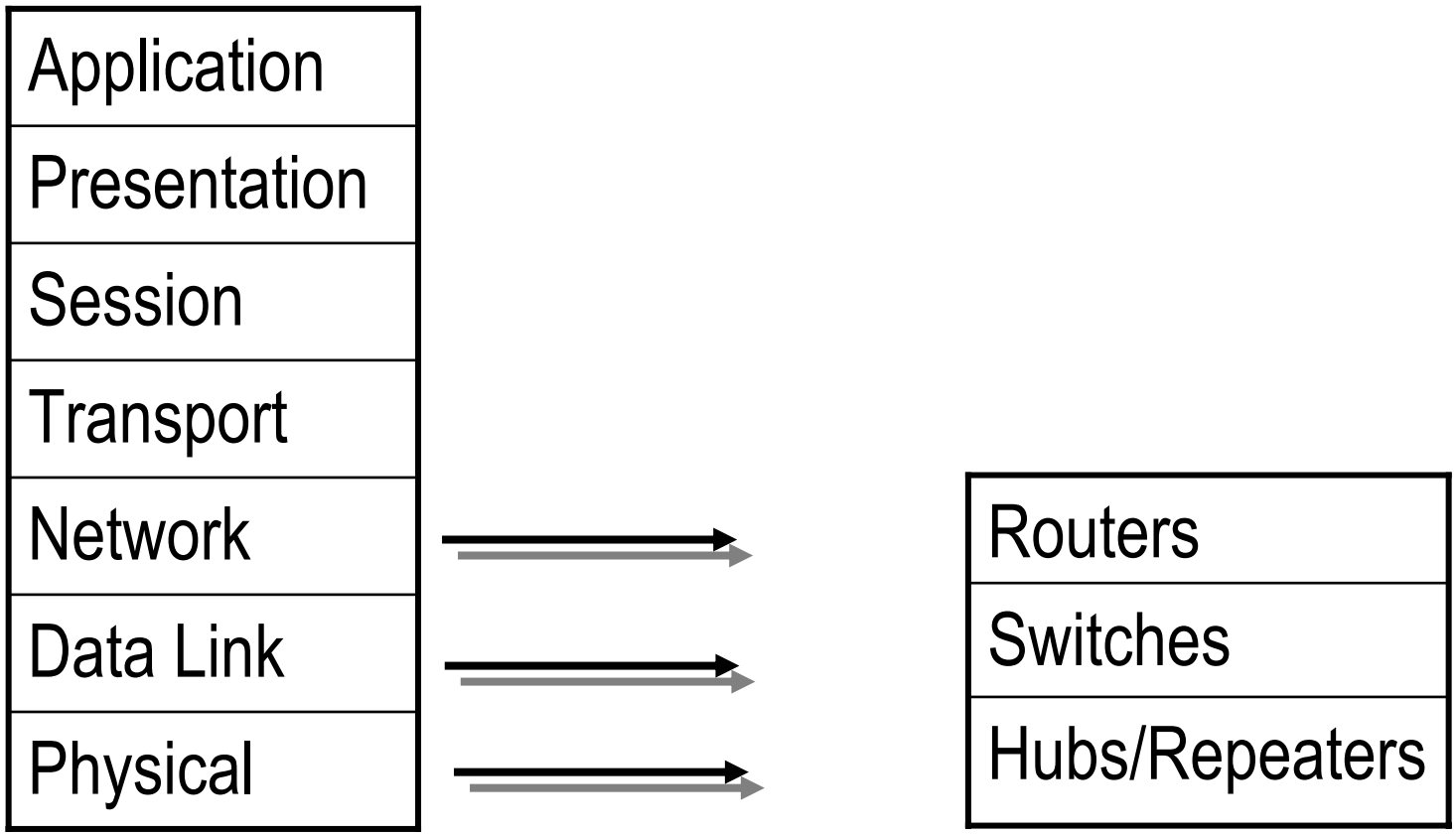
Packet

Frame

Bits

Devices at the different layers

- OSI Model



LAN Segmentation & Networking Essentials

Internetworking Fundamentals

MSTP

- Internetworks are the communication structures that work to tie Local Area Networks (LAN) and Wide Area Networks (WAN) together.
- Primary goal is to move information anywhere quickly upon demand and with complete integrity. Must be able to connect many different networks together to serve the organizations needs regardless of the type of physical media involved.

Internetworking Devices

MSTP

- LANs were designed to operate in limited geographical areas, such as one floor of a building, or a single building.
- LANs connect PCs together so that they can access network resources.
- A LAN connects physically adjacent devices on the network media or cable.
  - LAN Devices include: Repeaters, Bridges, Hubs, Switches, Routers, and Gateways.

Internetworking Devices Cont.

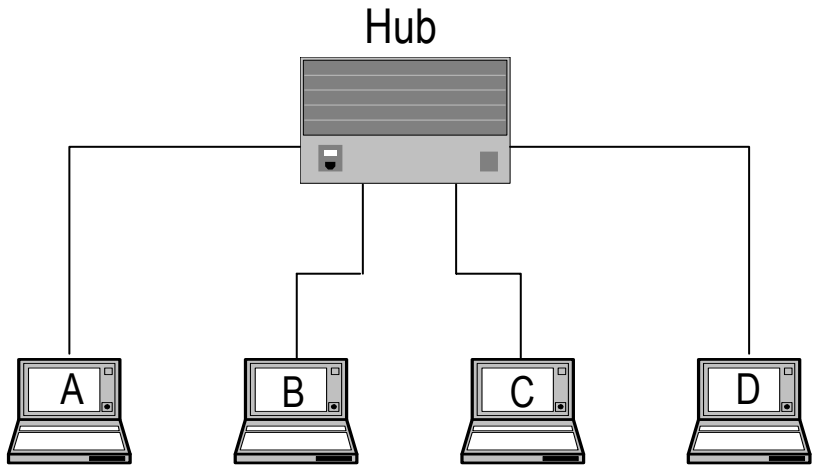
MSTP

- WANs extend beyond the LAN to connection networks located in different building, cities, states, and countries together.
- WANs are connected over ***serial*** lines.
  - WAN devices include: Routers, ATM Switches, X.25 and frame relay switches, modems, Channel Service Unit/Data Service Units (CSU/DSU), communication servers, and multiplexors.

Hubs

MSTP

APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK LLC/MAC)
Physical Layer

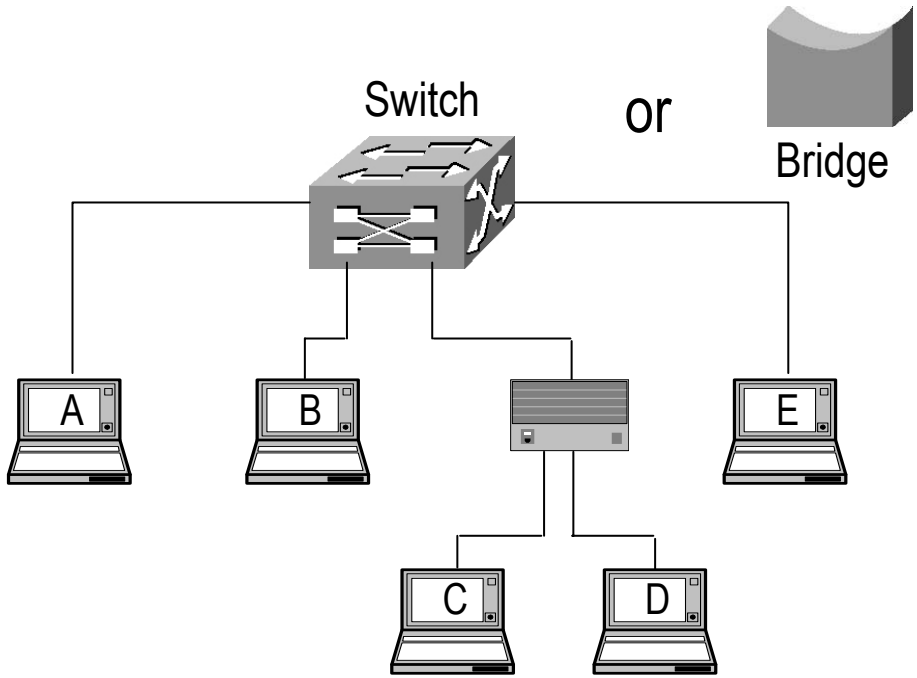


- All devices are in the same collision domain
- All devices are in the same broadcast domain
- All devices share the same bandwidth

Switches/Bridges

MSTP

APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK LLC/MAC)
Physical Layer



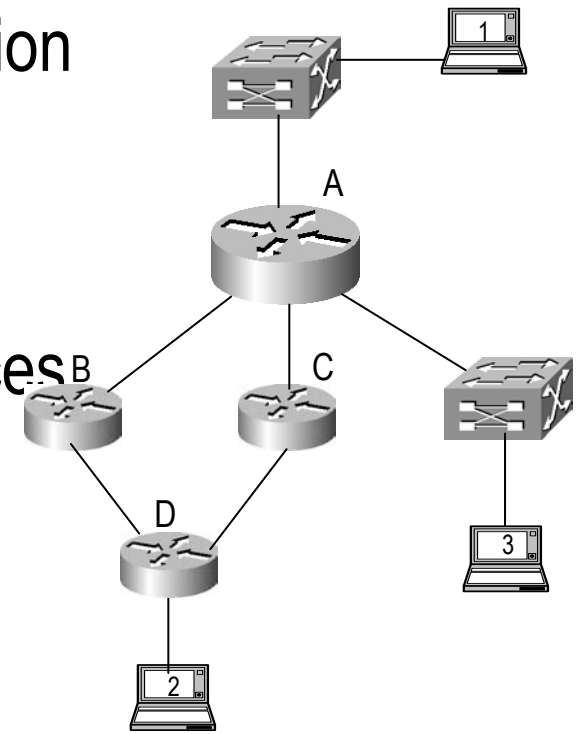
- Each Segment has its own collision domain
- All segments are in the same broadcast domain
- Listening, Learning, Filtering and Forwarding

Routers

MSTP

APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK LLC/MAC)
Physical Layer

- Broadcast control
- Multicast control
- Optimal path determination
- Traffic Management
- Logical addressing
- Connects to WAN services



Ethernet: Collisions

MSTP

- Certain level of collisions are expected on CSMA/CD LANs
- Excessive collisions can result from faulty components or overloaded segments
  - **Bad or excessively long cables**
  - **Bad NICs or transceivers**
- Establishing a baseline is helpful to determine normal levels
- Local collisions
  - **Occur on local LAN segment**
  - **Detected by circuitry in LAN interfaces**
- Remote collisions
  - **Occur on other side of repeater nodes**

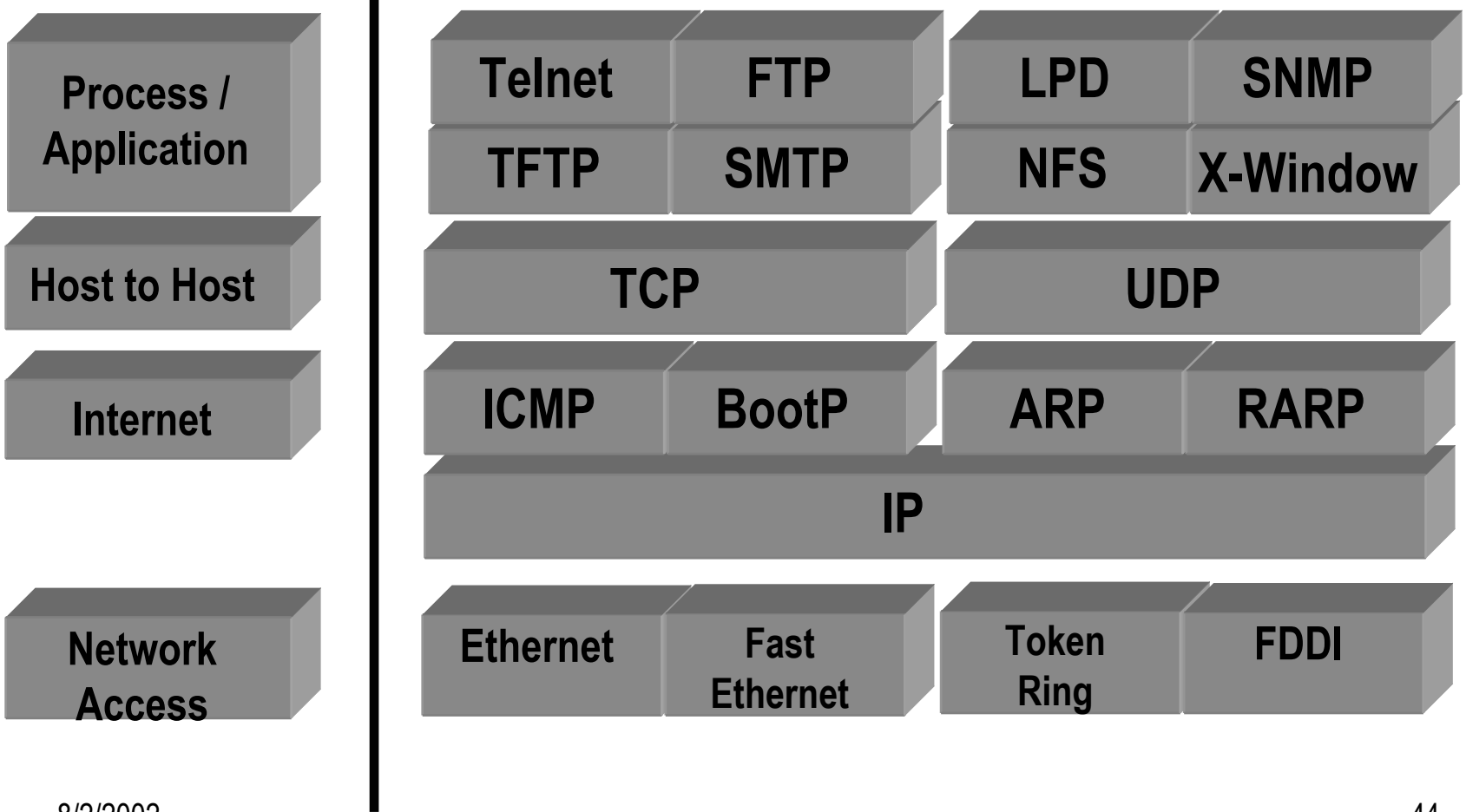
CSMA/CD

1. Sender is ready to send the frame. It listens to detect whether any frame is currently being received.
2. If Ethernet is silent, the devices begins to send the frame.
3. The sending device begins to listen to ensure that the frame it is sending does not collide with a frame that another station is sending.
4. If no collision occurs, the bits of the sent frame are received back successfully.
5 If a collision occurred, the device sends a jam signal and then waits a random amount of time before repeating the process.

TCP/IP Protocol Stack

TCP/IP Protocol Stack

MSTP

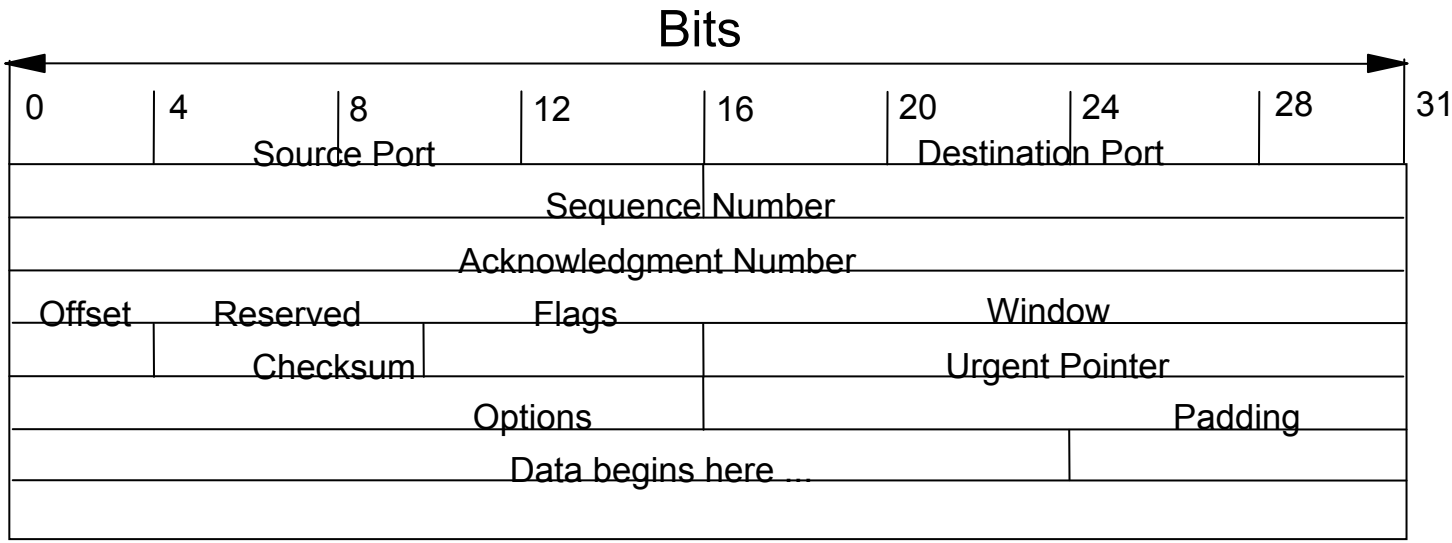


Transmission Control Protocol (TCP)

- Connection oriented
  - Connection must be established prior to data transfer
  - Adds overhead
- In sequence delivery
  - Uses segment numbers to guarantee packet arrival in sequence deliver
  - Adds error checking & sequence numbering
- Provides graceful release
  - Ensures all data sent is received
- Reliable
  - Acknowledgment of received packets

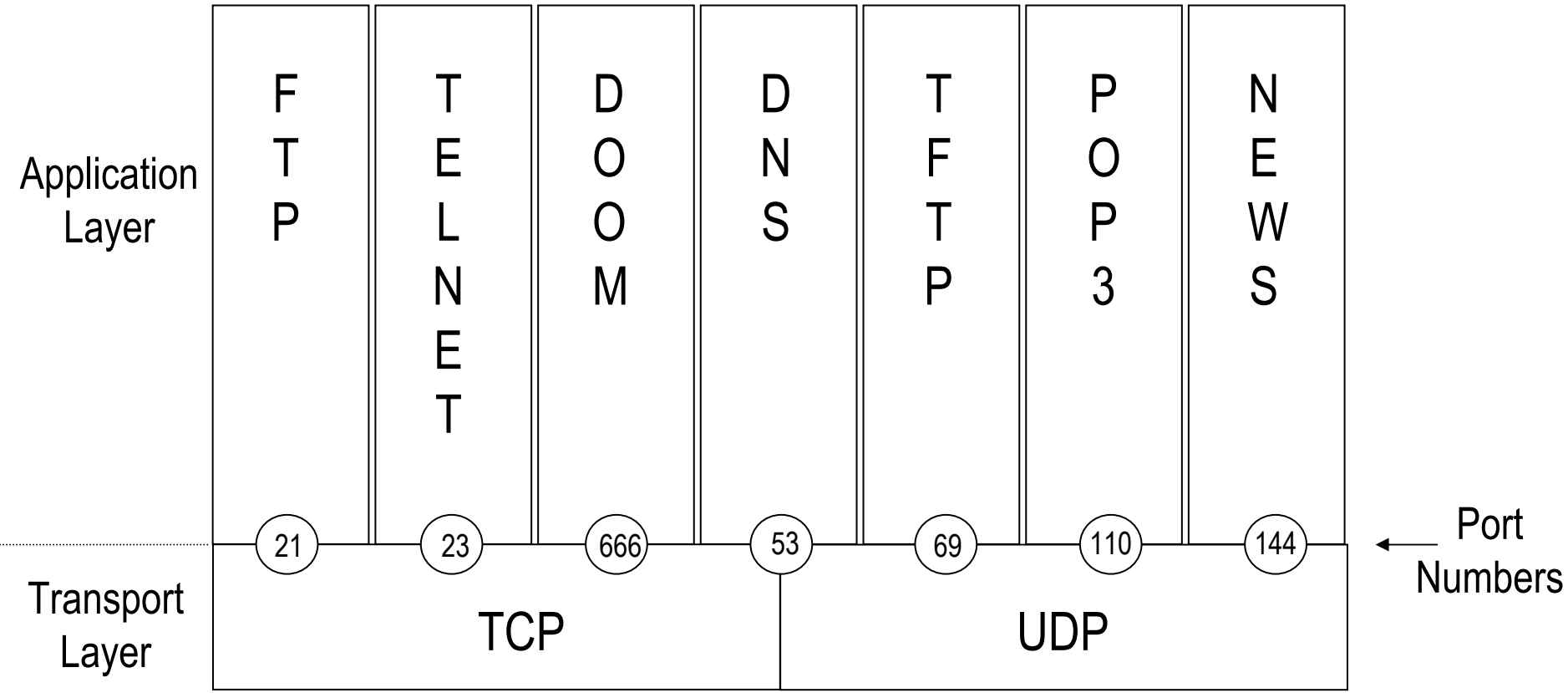
TCP Header

MSTP



TCP/UDP Port Examples

MSTP



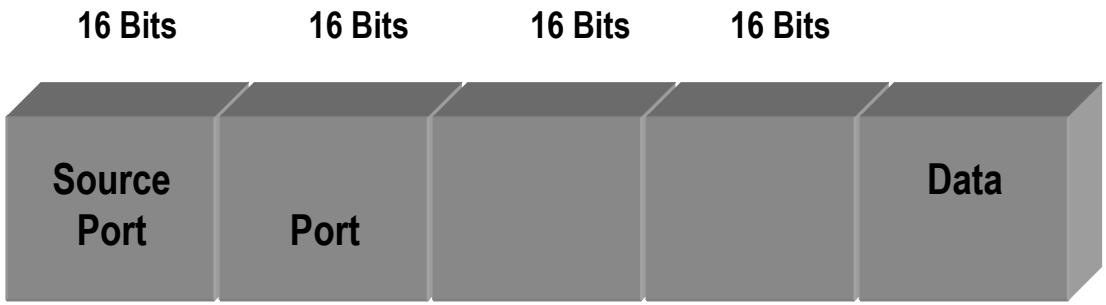
Port Number

- 0 – 255 are assigned to public applications
  - 80 is assigned for HTTP
- 256 – 1023 are assigned to “well known sockets”
  - 1752 is assigned for VTC
- 1024 and up are used to set up sessions
  - Randomly assigned

User Datagram Protocol (UDP)

- Used when all data fits in one packet
  - SNMP (Simple Network Management Protocol)
  - DNR (Domain Name Resolver)
  - NBT (NetBIOS over TCP/IP)
- Unreliable
  - No acknowledgment at this layer
- User data integrity
  - Adds header and computes checksum
- Why use UDP?
  - Lower overhead
  - Small amount of data for transmission
  - Less overhead to retransmit if data lost
  - Application entity has its own reliability built in

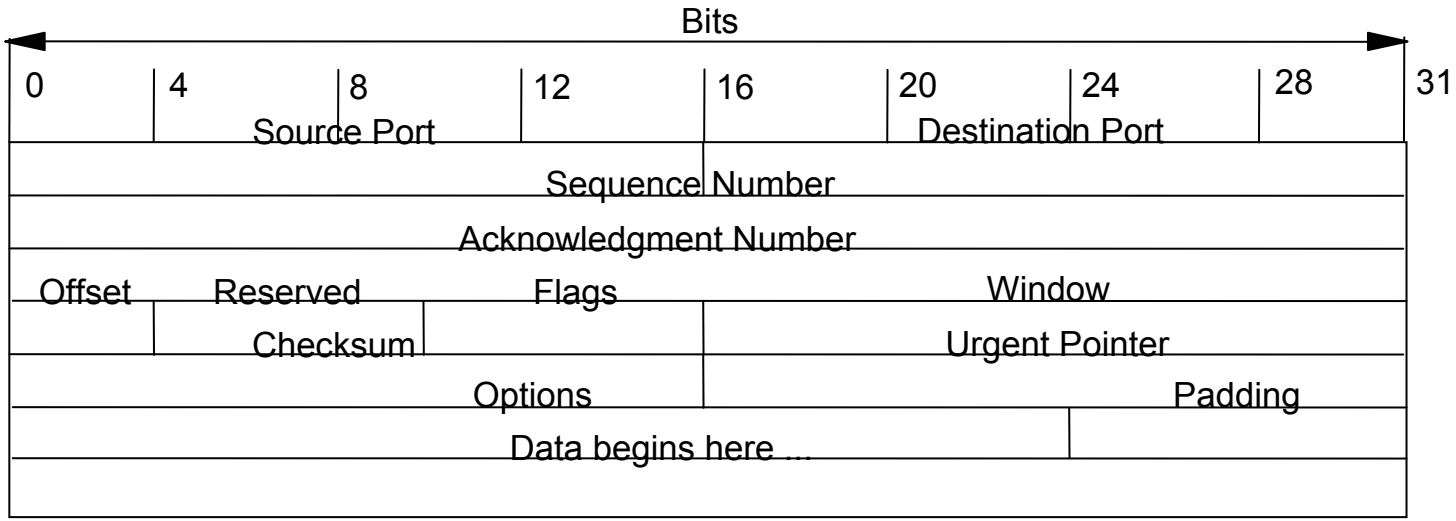
UDP Header



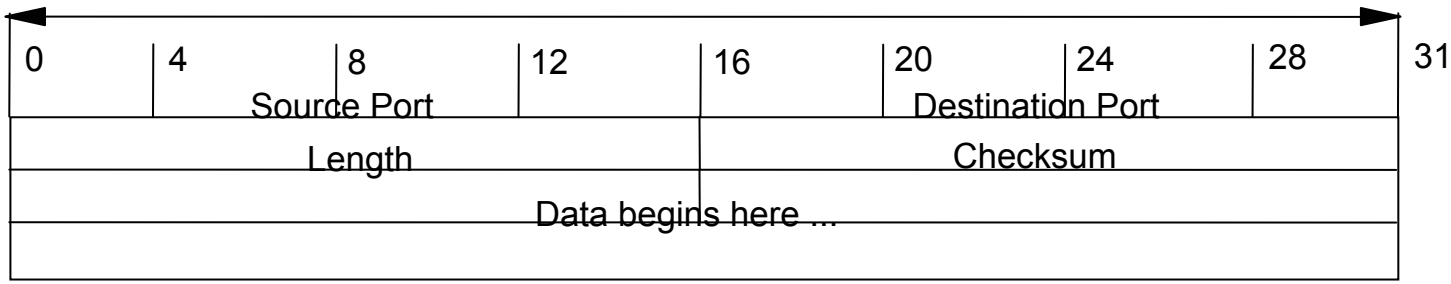
TCP vs. UDP Header

MSTP

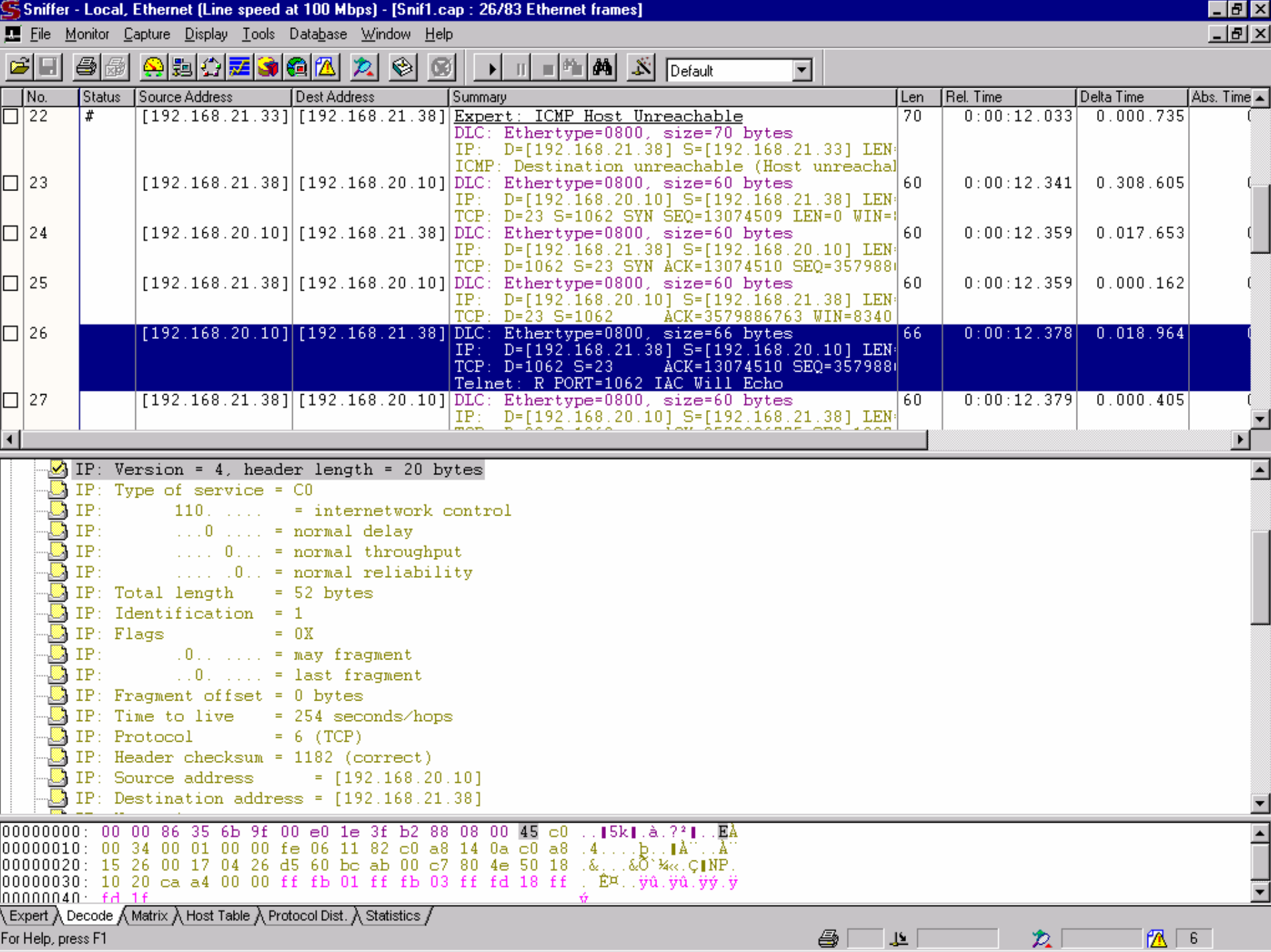
TCP Header

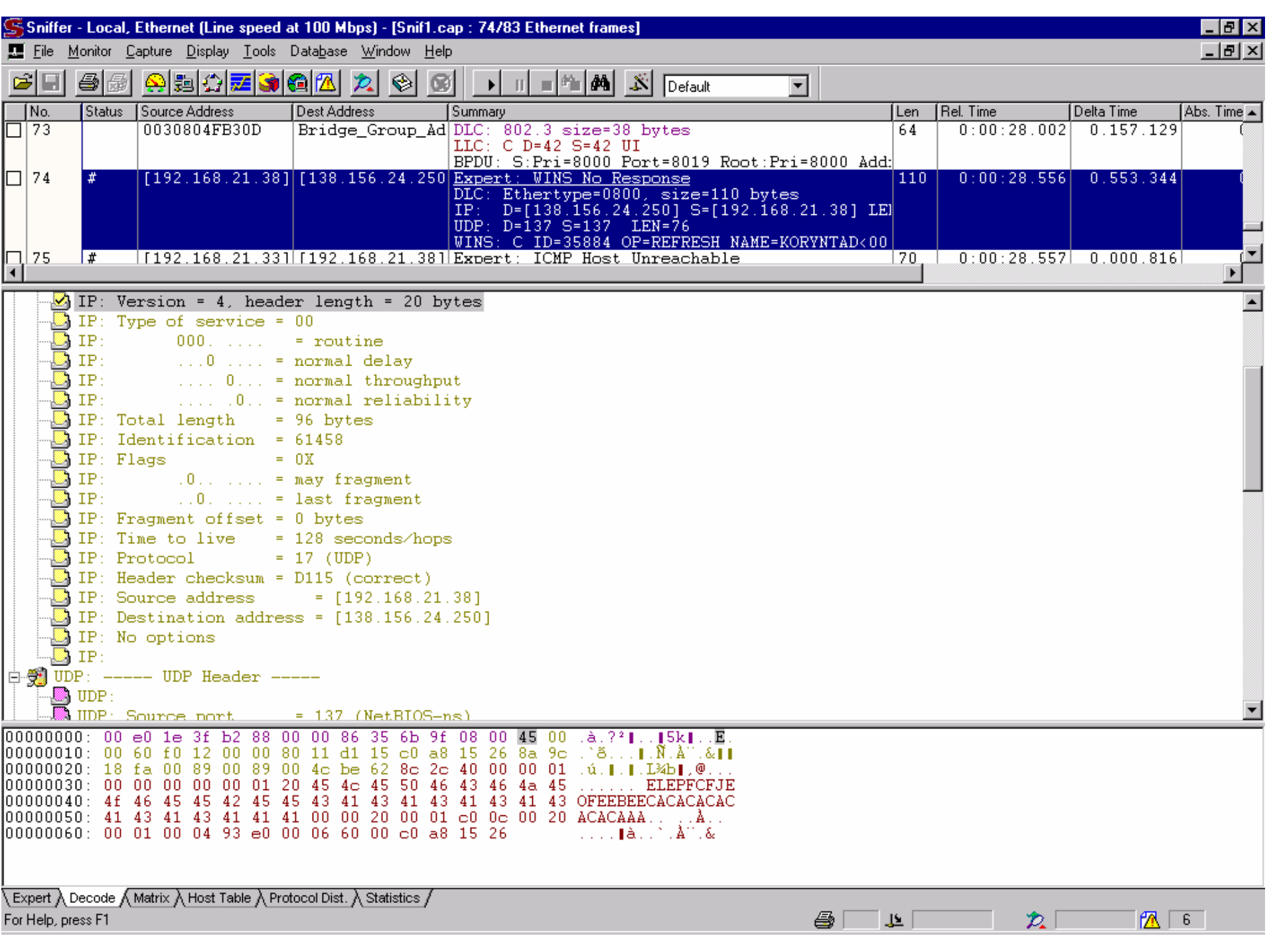


UDP Header



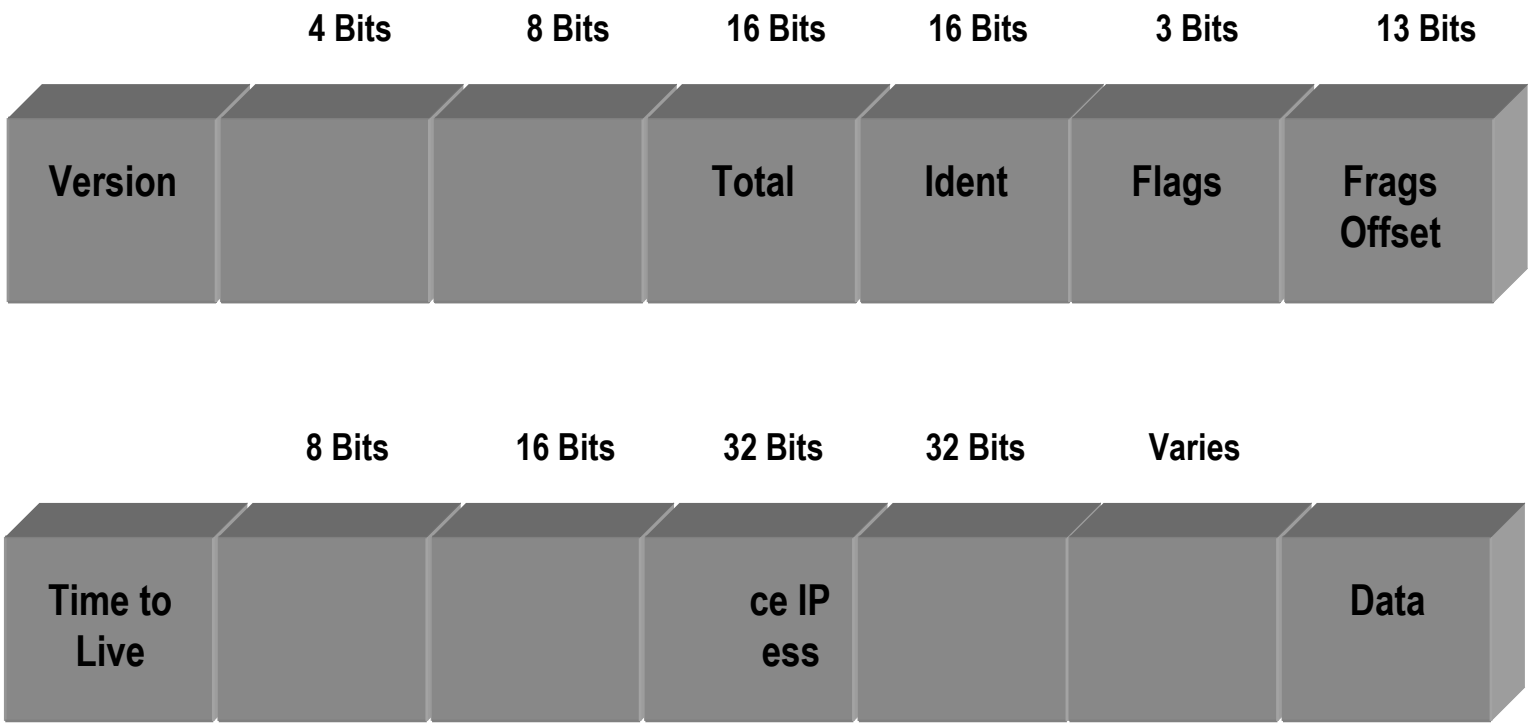

Bring out the Sniffer


Sniffer - Local, Ethernet (Line speed at 100 Mbps) - [Snif1.cap : 26/83 Ethernet frames]
File Monitor Capture Display Tools Database Window Help
Default
No. Status Source Address Dest Address Summary Len Rel. Time Delta Time Abs. Time
22 # [192.168.21.33] [192.168.21.38] Expert: ICMP Host Unreachable 70 0:00:12.033 0.000.735
DLC: Ethertype=0800, size=70 bytes
IP: D=[192.168.21.38] S=[192.168.21.33] LEN
ICMP: Destination unreachable (Host unreacha
23 [192.168.21.38] [192.168.20.10] DLC: Ethertype=0800, size=60 bytes 60 0:00:12.341 0.308.605
IP: D=[192.168.20.10] S=[192.168.21.38] LEN
TCP: D=23 S=1062 SYN SEQ=13074509 LEN=0 WIN=
24 [192.168.20.10] [192.168.21.38] DLC: Ethertype=0800, size=60 bytes 60 0:00:12.359 0.017.653
IP: D=[192.168.21.38] S=[192.168.20.10] LEN
TCP: D=1062 S=23 SYN ACK=13074510 SEQ=357988
25 [192.168.21.38] [192.168.20.10] DLC: Ethertype=0800, size=60 bytes 60 0:00:12.359 0.000.162
IP: D=[192.168.20.10] S=[192.168.21.38] LEN
TCP: D=23 S=1062 ACK=3579886763 WIN=8340
26 [192.168.20.10] [192.168.21.38] DLC: Ethertype=0800, size=66 bytes 66 0:00:12.378 0.018.964
IP: D=[192.168.21.38] S=[192.168.20.10] LEN
TCP: D=1062 S=23 ACK=13074510 SEQ=357988
Telnet: R PORT=1062 IAC Will Echo
27 [192.168.21.38] [192.168.20.10] DLC: Ethertype=0800, size=60 bytes 60 0:00:12.379 0.000.405
IP: D=[192.168.20.10] S=[192.168.21.38] LEN
IP: Version = 4, header length = 20 bytes
IP: Type of service = C0
IP: 110. .... = internetwork control
IP: ...0 .... = normal delay
IP: .... 0... = normal throughput
IP: .... .0.. = normal reliability
IP: Total length = 52 bytes
IP: Identification = 1
IP: Flags = 0X
IP: .0.. .... = may fragment
IP: ..0. .... = last fragment
IP: Fragment offset = 0 bytes
IP: Time to live = 254 seconds/hops
IP: Protocol = 6 (TCP)
IP: Header checksum = 1182 (correct)
IP: Source address = [192.168.20.10]
IP: Destination address = [192.168.21.38]
00000000: 00 00 86 35 6b 9f 00 e0 1e 3f b2 88 08 00 45 c0
00000010: 00 34 00 01 00 00 fe 06 11 82 c0 a8 14 0a c0 a8
00000020: 15 26 00 17 04 26 d5 60 bc ab 00 c7 80 4e 50 18
00000030: 10 20 ca a4 00 00 ff fb 01 ff fb 03 ff fd 18 ff
00000040: fd 1f
Expert Decode Matrix Host Table Protocol Dist. Statistics
For Help, press F1
6


Sniffer - Local, Ethernet (Line speed at 100 Mbps) - [Snif1.cap : 74/83 Ethernet frames]
File Monitor Capture Display Tools Database Window Help
Default
No. Status Source Address Dest Address Summary Len Rel. Time Delta Time Abs. Time
73 0030804FB30D Bridge_Group_Ad DLC: 802.3 size=38 bytes
LLC: C D=42 S=42 UI
BPDU: S:Pri=8000 Port=8019 Root:Pri=8000 Add: 64 0:00:28.002 0.157.129
74 # [192.168.21.38] [138.156.24.250 Expert: WINS No Response
DLC: Ethertype=0800, size=110 bytes
IP: D=[138.156.24.250] S=[192.168.21.38] LE
UDP: D=137 S=137 LEN=76
WINS: C ID=35884 OP=REFRESH NAME=KORYNTAD<00 110 0:00:28.556 0.553.344
75 # [192.168.21.33] [192.168.21.38] Expert: ICMP Host Unreachable 70 0:00:28.557 0.000.816
IP: Version = 4, header length = 20 bytes
IP: Type of service = 00
IP: 000. .... = routine
IP: ...0 .... = normal delay
IP: .... 0... = normal throughput
IP: .... .0.. = normal reliability
IP: Total length = 96 bytes
IP: Identification = 61458
IP: Flags = 0X
IP: .0.. .... = may fragment
IP: ..0. .... = last fragment
IP: Fragment offset = 0 bytes
IP: Time to live = 128 seconds/hops
IP: Protocol = 17 (UDP)
IP: Header checksum = D115 (correct)
IP: Source address = [192.168.21.38]
IP: Destination address = [138.156.24.250]
IP: No options
IP:
UDP: ----- UDP Header -----
UDP:
UDP: Source port = 137 (NetBIOS-ns)
00000000: 00 e0 1e 3f b2 88 00 00 86 35 6b 9f 08 00 45 00 .à.?²▮..▮5k▮..E.
00000010: 00 60 f0 12 00 00 80 11 d1 15 c0 a8 15 26 8a 9c .`ð...▮.Ñ.À¨.&▮▮
00000020: 18 fa 00 89 00 89 00 4c be 62 8c 2c 40 00 00 01 .ú.▮.▮.L¾b▮,@...
00000030: 00 00 00 00 00 01 20 45 4c 45 50 46 43 46 4a 45 ..... ELEPFCFJE
00000040: 4f 46 45 45 42 45 45 43 41 43 41 43 41 43 41 43 OFEEBEECACACACAC
00000050: 41 43 41 43 41 41 41 00 00 20 00 01 c0 0c 00 20 ACACAAA.. ..À..
00000060: 00 01 00 04 93 e0 00 06 60 00 c0 a8 15 26 ....▮à..`.À¨.&
Expert Decode Matrix Host Table Protocol Dist. Statistics
For Help, press F1
6

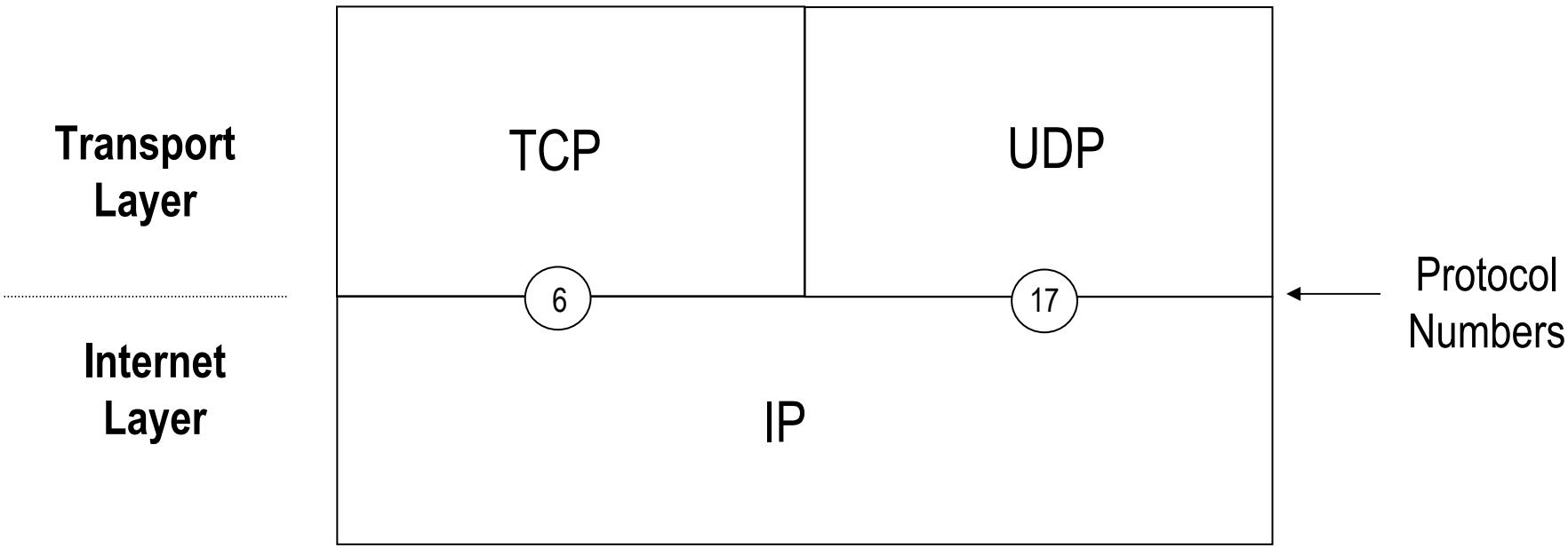
IP Header

MSTP



IP Port has to be either

MSTP



Network Interface Layer Addressing

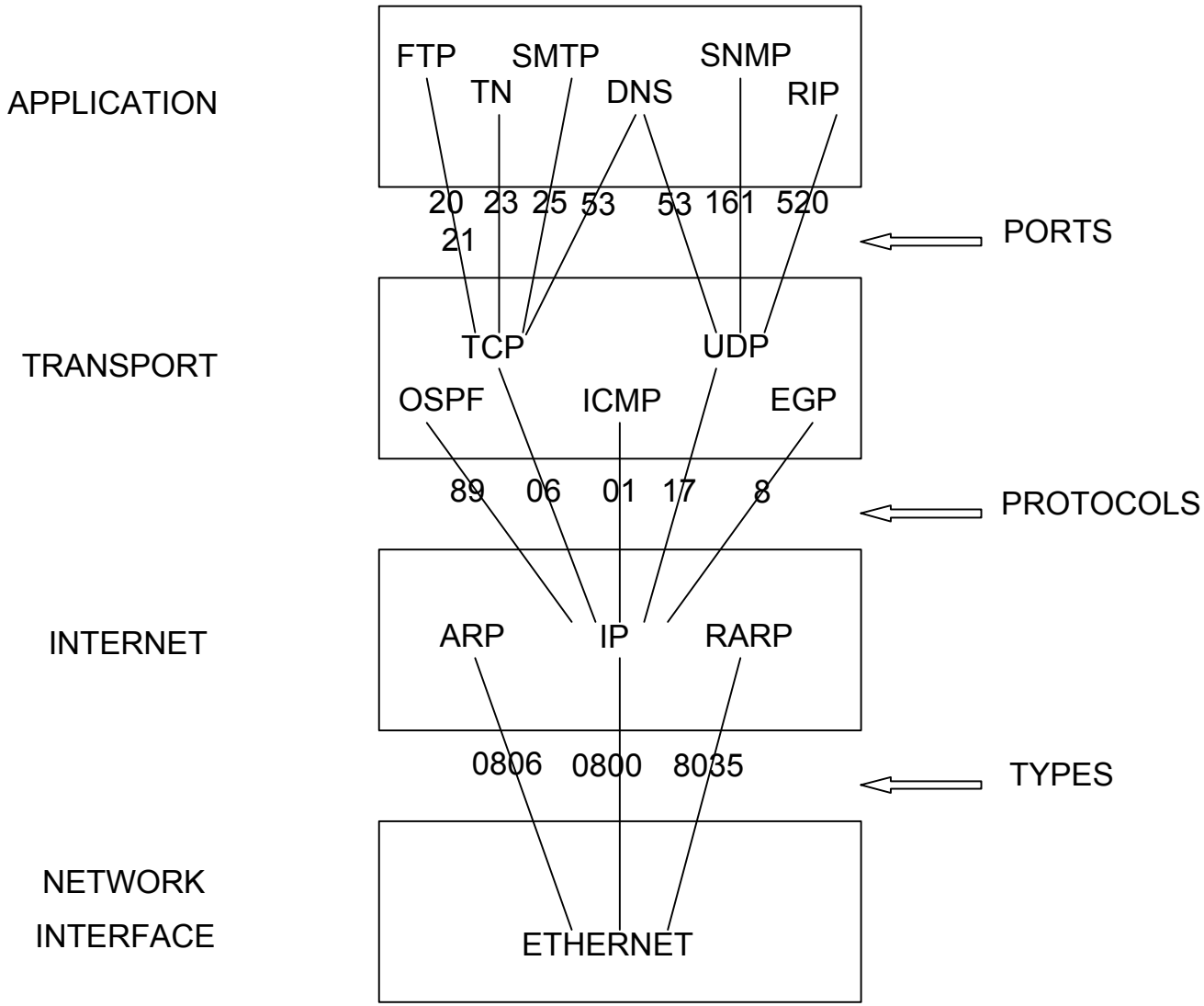
- Hardware address
- MAC address
- Ethernet address
- 48 bits
- 05 23 33 20 00 f4
- 2 portions
  - Vendor code
    - First 6 characters
    - Assigned by IEEE
  - Unique hardware address
    - Last 6 characters
    - Assigned by vendor
- Actual address to which frames are sent

Network Interface Card

- Network Interface Card (NIC) listens for:
  - It's hardware address
  - Broadcast address
  - Multicast address
- Decision Process
  - Ethernet NIC
    - Mine - Pass it to internet layer
    - Not Mine - Discard
  - Token Ring NIC
    - Mine - Pass it to internet layer
    - Not Mine - Regenerate and pass along

Inter-layer Communication

MSTP



Request for Comments (RFC)

- The internet explains the open standard that makes up TCP/IP and related Internet protocols in Request for Comments (RFC's)

- RFC's are also written on many networking topics. Each new and received/replacement RFC is assigned a sequential number in the order that they are submitted.

Address Resolution Protocol (ARP)

- RFC 826
- Converts network address to hardware address
  - Deliver data from one host to another on same network
- Supported by majority of vendor's implementations
- Sender knows network address but not hardware address
  - Sender broadcasts ARP request to all hosts
  - All interfaces receive ARP request
    - If not mine, drop
    - If mine, reply to send
  - Sender caches hardware and network address
  - Sender sends data to recipient

Reverse Address Resolution Protocol (RARP)

- RFC 903 / 906
- Maps hardware addresses to network addresses
- Allows diskless clients to learn their own network addresses
- Workstation knows hardware address but not network address
  - Workstation broadcasts RARP request onto network
  - RARP server responds with network address
- Special chipset on NIC required
- RARP server must be available and configured

IP Addressing & Classes

Table of Contents

MSTP

- IP Addressing
- Subnetting
- Questions
- Summarization

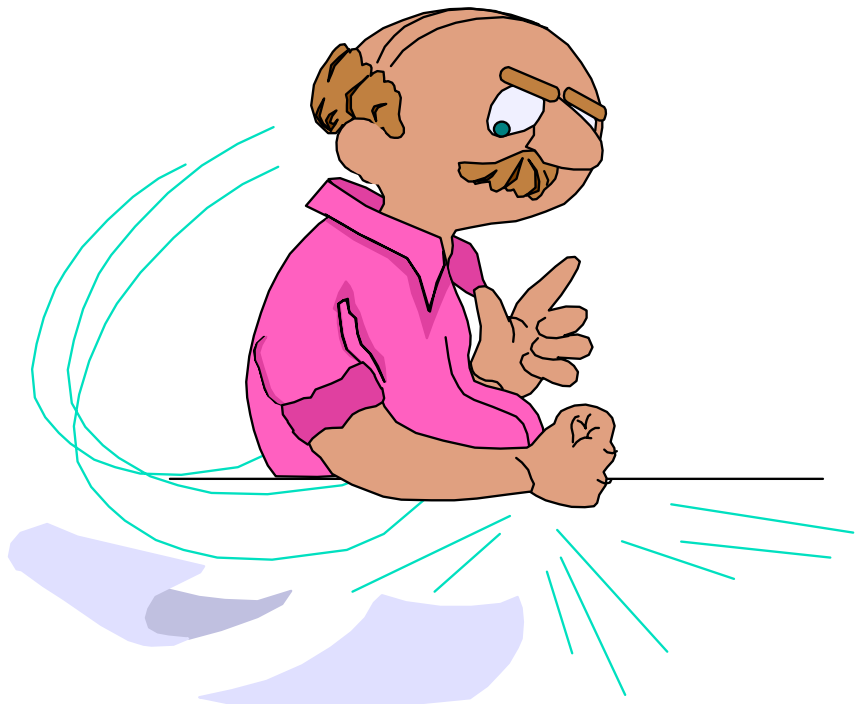
Binary to Decimal Conversion

MSTP

128	64	32	16	8	4	2	1	
0	0	0	0	0	0	0	0	00000000 = 0
1	1	1	1	1	1	1	1	11111111 = 255
0	0	0	0	1	1	1	1	00001111 = 15
0	1	0	1	0	1	0	1	01010101 = 85

Binary (Cont.)

- 00000000 = 0
- 10000000 = 128
- 11000000 = 192
- 11100000 = 224
- 11110000 = 240
- 11111000 = 248
- 11111100 = 252
- 11111110 = 254
- 11111111 = 255

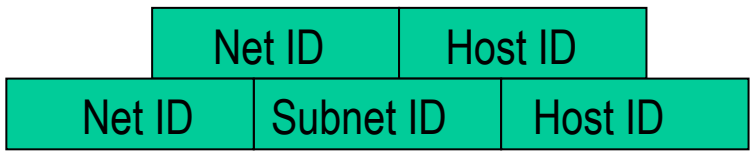


IP Addressing

MSTP

- 32 BITS - 4 BYTES –
- MUST BE UNIQUE FOR EACH HOST IN NETWORK (8 BITS = 1 BYTE)
  - 192.168.20.10
  - 192.168.31.33

- 2 [3] PORTIONS
  Network portion – Relative to the class of IP. Identifies the network and is common to all devices attached to that network.
  Host portion - also relative to class as well as identifies a particular device attached to that network.
  [Subnet portion]



Addressing/Classes

- xxx.xxx.xxx.xxx **n =network h=host address**
  - **192.156.2.169 (IPv4)**

- **Class A** nnn.hhh.hhh.hhh **1 - 126**
  - Only 126 networks, but 16,777,214 hosts apiece
    - **127.0.0.1 = Local loop back address**
- **Class B** nnn.nnn.hhh.hhh **128 - 191**
  - 16,384 networks with 65,534 hosts apiece

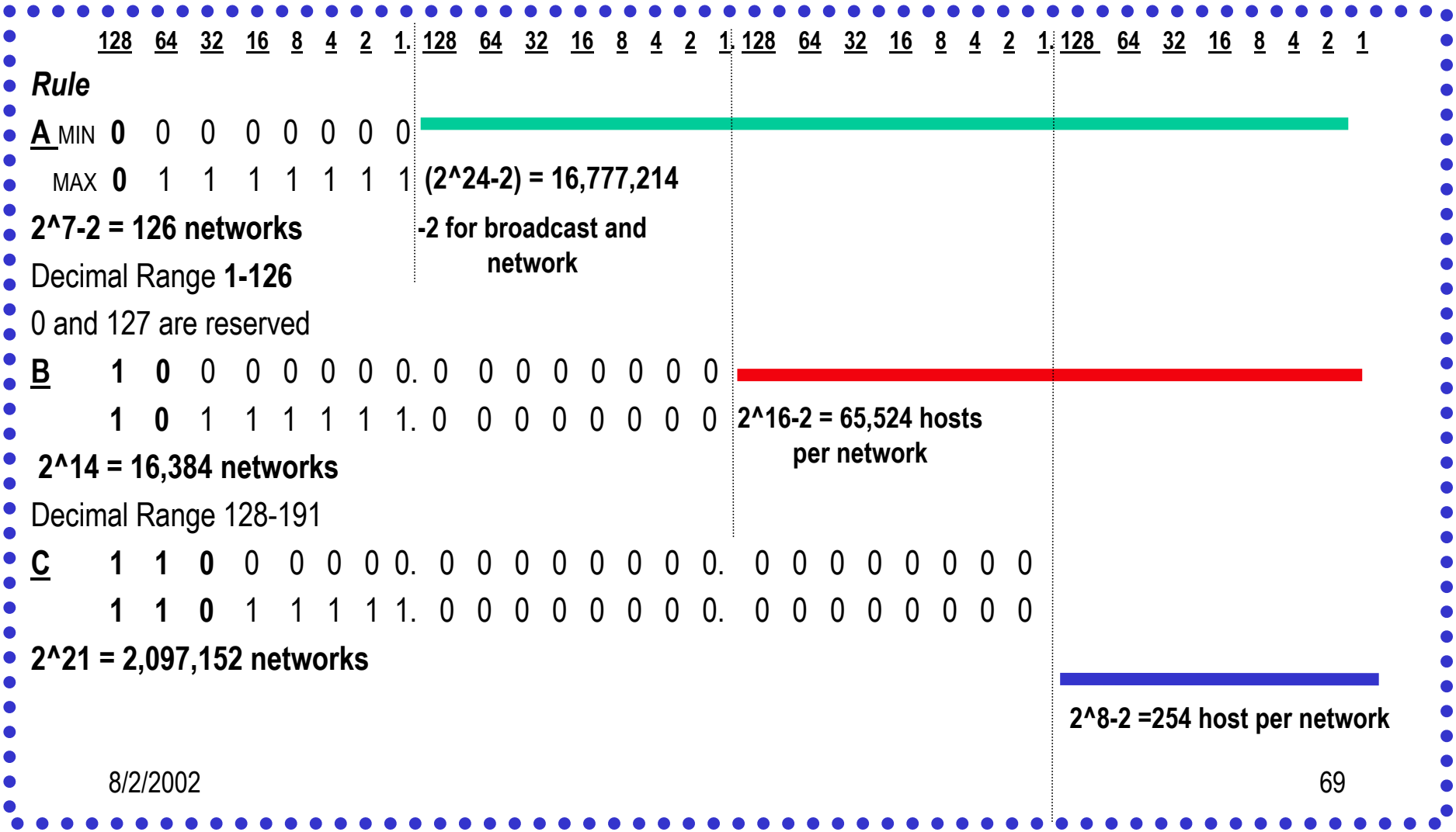
- **Class C** nnn.nnn.nnn.hhh **192 - 223**
  - 2,097,152 networks with 254 hosts apiece

- **Class D - used for multicasting (audio/video)**

- **Class E - currently reserved / future**

Class Conversion

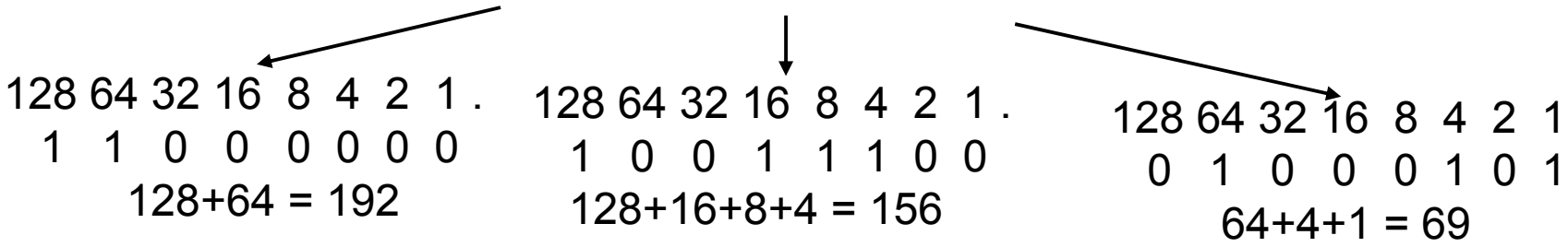
MSTP



Decimal to Binary Example

MSTP

192.156.69.0 = 11000000.10011100.01000101.00000000 Class C



Let Practice!!

Reserved IP Addresses

- IP address for Hosts cannot have:

  ALL 1's or ALL 0's (binary) in the NETWORK portion
  OR
  ALL 1's or ALL 0's (binary) in the HOST portion

  - All 1's in the host portion of a target IP address signifies a Broadcast
  - All 0's in the host portion of a IP address identify a subnet or network

- Network: 138.156.0.0 = 10001010.10011110.00000000.00000000
  Broadcast:138.156.255.255 = 10001010.10011110.11111111.11111111
  Host: 138.156.100.100 = 10001010.10011110.01100100.01100100

  Network: 192.156.80.0 = 11000000.10011100.01010000.00000000
  Broadcast: 192.156.80.255 = 11000000.10011100.01010000.11111111
  Host: 192.156.80.200 = 11000000.10011100.01010000.11001000

IP Addresses

- ASSIGNED by Node Site Coordinator
  - Address assignment planning
  - Node Site Coordinator
  - Draw out your network
  - Same "physical" net means same ”IP Network”
  - Each "interface" has a "unique" IP address
  - “Don't" assign reserved addresses

- RECOMMENDATIONS
  - FIRST 10 addresses reserved for router interfaces
  - LAST address reserved for domain name server

SUBNETTING

Terminology

- Address Mask – All network bits set to 1 and all host bits set to 0
- Subnet - A subnetwork of a major class A, B, C address space
- Subnet Mask - A mask longer than the standard address mask - determined by subnet scheme.

IP Address Terminology

MSTP

- **NETWORK NUMBER**- When all host bits are turned off (0).
- **BROADCAST ADDRESS**- When all host bits are turned on (1).
- **HOST ADDRESS**- A unique IP address assigned to a workstation, interface or user, that is in between the network number and broadcast address.
- **SUBNET MASK**-Used to tell the machine what subnetting scheme is being implemented on the network. Found by turning all network bits on (1), including those host bits that have been given to the network side.
- **SUBNETTING** - Dividing up an entire Class network by sacrificing original host (H) bits to the network (N).

SUBNETTING

- WHAT IS IT?
  Divides host (H) portion into smaller networks

- WHY?
  Stops wasting network numbers

- WHO?
  Node site coordinator

- WHAT DETERMINES?
  Number of different physical networks and number of hosts

Subnetting

- When you borrow bits from the main network address's host section, TCP/IP must be told which bits of the host section are borrowed to be used as the network address.

- We use a subnet mask to define the number of bits used to create additional networks.

- **Remember** - the more bits used to define the mask, the fewer the hosts and the more the networks

Default Subnet Mask

Your network has a subnet mask even if it doesn't have subnets.

CLASS A DEFALUT = 255.0.0.0

11111111.00000000.00000000.00000000

CLASS B DEFAULT = 255.255.0.0

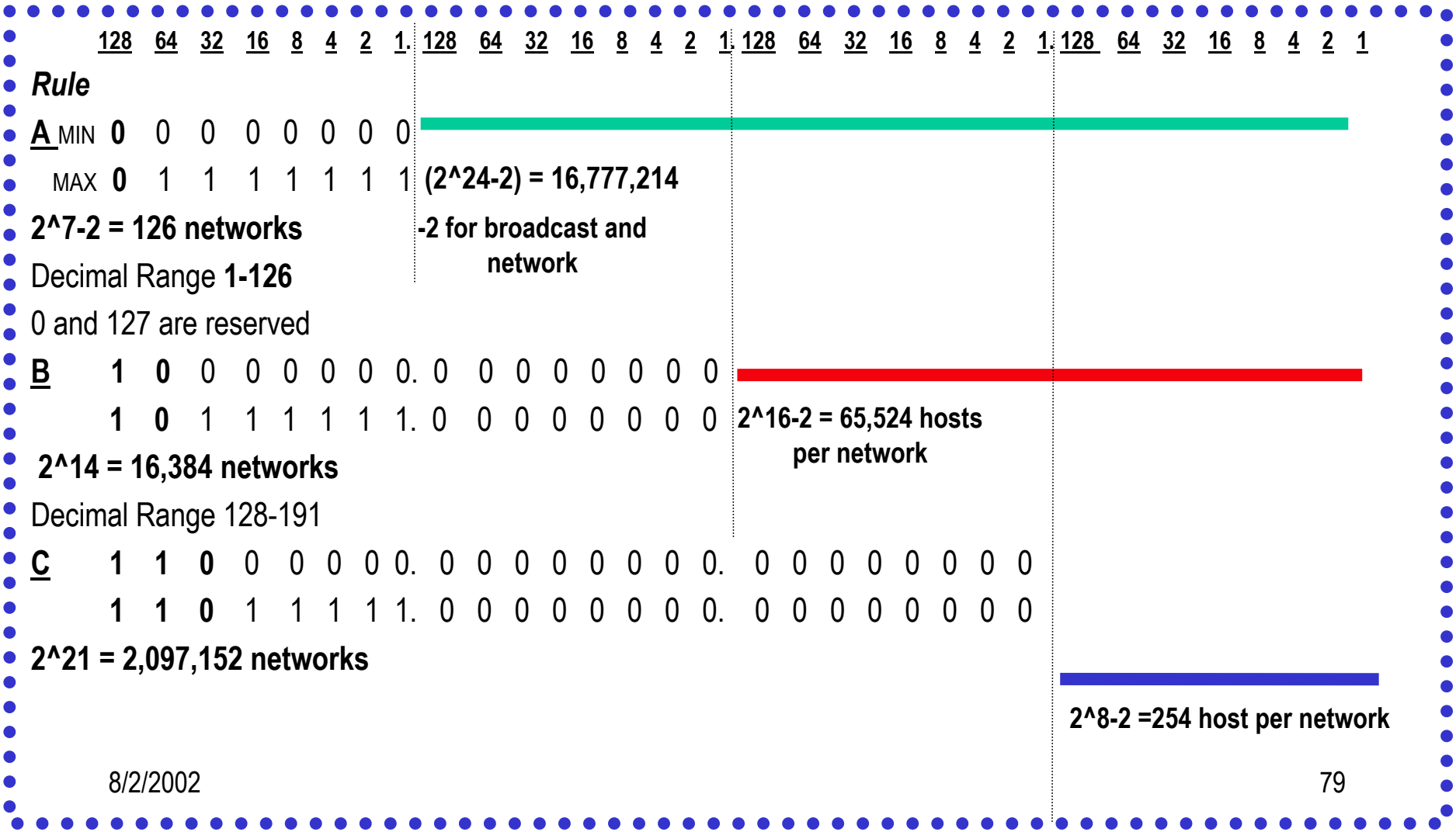
11111111.11111111.00000000.00000000

CLASS C DEFAULT = 255.255.255.0

11111111.11111111.11111111.00000000

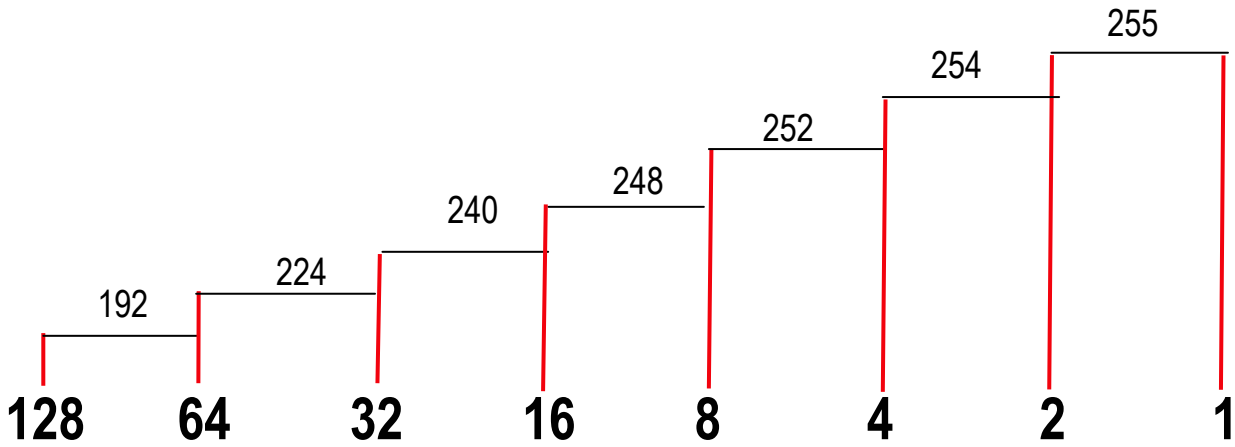
Class Conversion

MSTP



Subnet Bit Chart

MSTP



* SUBNET BITS COME FROM THE HIGHEST-ORDER BITS TO THE LOW ORDER BITS OF THE **HOST** FIELD

How Subnetting Works

N				H			
128	64	32	16	8	4	2	1

MASK = 128+64+32+16
240

16-(2) # hosts per network
- all 0's network
- all 1's broadcast
leaves 14 per net

N				H				
128	64	32	16	8	4	2	1	
0	0	0	1	0	0	0	0	16 Network
0	0	0	1	0	0	0	1	17 1st host
0	0	0	1	0	0	1	0	18
0	0	0	1	0	0	1	1	19
:	:	:	:	:	:	:	:	
0	0	0	1	1	1	1	1	31 Broadcast
0	0	1	0	0	0	0	0	32 Network
0	0	1	0	0	0	0	1	33 1st host

Determining Subnet Mask


```
                                  N                 H
192.156.69.0= 11000000.10011100.01000101.00000000   Class C  N.N.N.H
                          N                 H
143.211.0.0  = 10001111.11010011.00000000.00000000   Class B  N.N.H.H
```

Subnet Mask is the address with every network bit turned on. This tells the router that you want to use some Host bits as network (subnet) bits.

```
                                  N                 H
192.156.69.0= 11000000.10011100.01000101.00000000   Class C  N.N.N.H
Subnet Mask= 11111111.11111111.11111111.00000000   255.255.255.0
                                  N                 H
with 4 bit   = 11111111.11111111.11111111.11110000   255.255.255.240
                          N                 H
143.211.0.0  = 10001111.11010011.00000000.00000000   Class B  N.N.H.H
Subnet Mask= 11111111.11111111.00000000.00000000   255.255.0.0
                                  N                 H
with 8 bit   = 11111111.11111111.11111111.00000000   255.255.255.0
```

Subnetting Reference Charts

MSTP

CLASS B

# BITS	SUBNET MASK	# SUBNETS	# HOSTS
2	255.255.192.0	2	16382
3	255.255.224.0	6	8190
4	255.255.240.0	14	4094
5	255.255.248.0	30	2046
6	255.255.252.0	62	1022
7	255.255.254.0	126	510
8	255.255.255.0	254	254
9	255.255.255.128	510	126
10	255.255.255.192	1022	62
11	255.255.255.224	2046	30
12	255.255.255.240	4094	14
13	255.255.255.248	8190	6
14	255.255.255.252	16382	2

Subnetting Reference Charts

MSTP

CLASS C

# BITS	SUBNET MASK	# SUBNETS	# HOSTS
2	255.255.255.192	2	62
3	255.255.255.224	6	30
4	255.255.255.240	14	14
5	255.255.255.248	30	6
6	255.255.255.252	62	2

Steps in Subnetting

MSTP

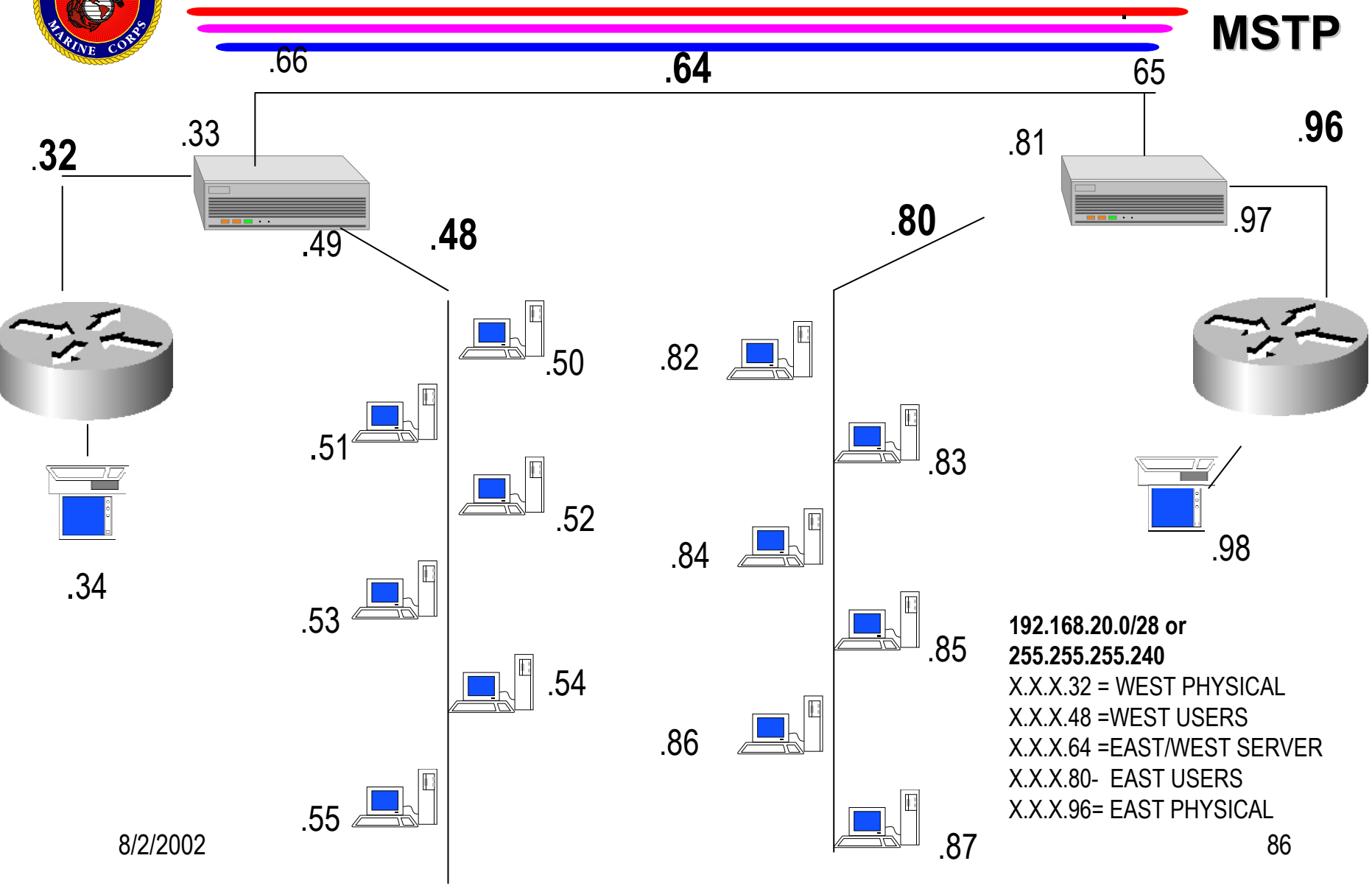
1. Write Out the Subnet Mask
2. Answer What You Know
3. Write Out in Binary
4. Apply Logical And (or Anding)
5. Turn on all the host bits

192.168.25.45 / 27

192.168.25.45
255.255.255.224
192.168.25.??

128	64	32	16	8	4	2	1
1	1	1	0	0	0	0	0
0	0	1	0	1	1	0	1
0	0	1	0	0	0	0	0
0	0	1	1	1	1	1	1

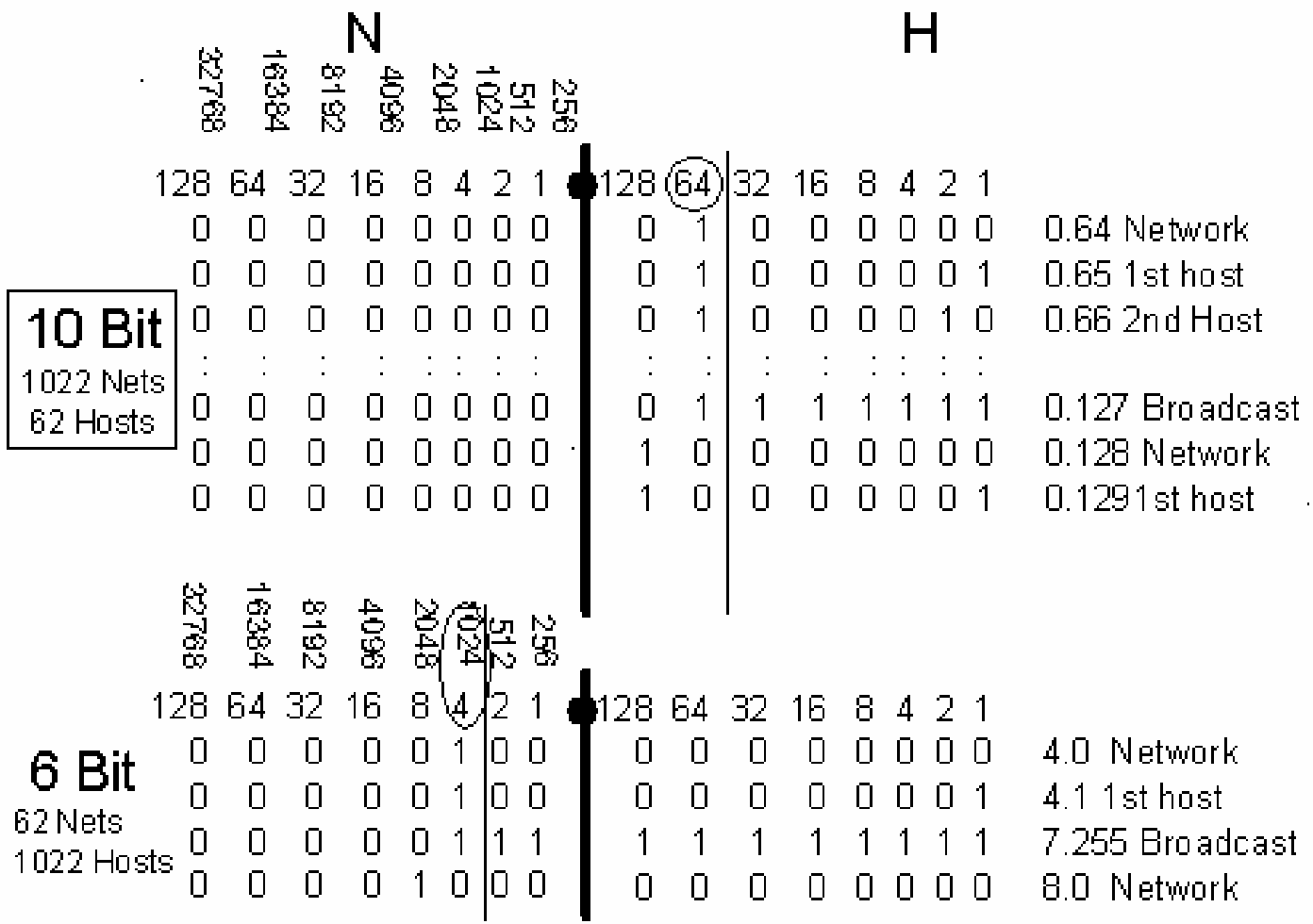
Sample Subnetted Network



192.168.20.0/28 or
255.255.255.240
X.X.X.32 = WEST PHYSICAL
X.X.X.48 =WEST USERS
X.X.X.64 =EAST/WEST SERVER
X.X.X.80- EAST USERS
X.X.X.96= EAST PHYSICAL

Going Beyond The Octet

MSTP



Finding A Host's Network

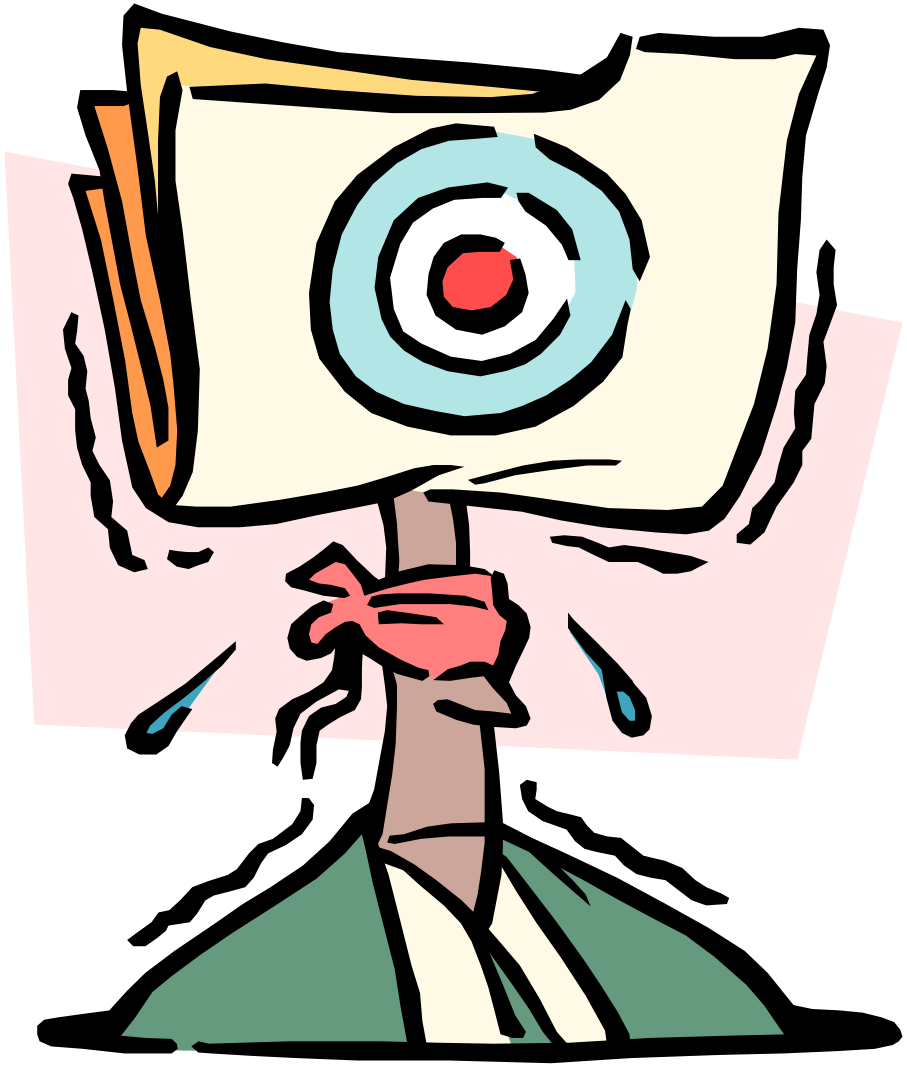
	N	H
Host: 192.156.69.78 =	11000000.10011100.01000101.0100	1110
Subnet Mask 4 bit =	11111111.11111111.11111111.1111	0000
Host Network ID # =	11000000.10011100.01000101.0100	0000

Network bits total 192.156.69.64
which is not all 1's or all 0's.

Host bits = 1110 which is not all 1's or all 0's so it is legal, it is the 14th host on the .64 network.

Is there another way?

MSTP



Five Questions

- 1. How many subnets?
- 2. How many hosts per subnet?
- 3. What are the subnets?
- 4. What are the valid hosts in each subnet?
- 5. What is the broadcast address of each subnet?

Begin to answer by…

1. Determine how many networks you need.
2. Find out how many hosts are required for each network (use the highest number of hosts).
3. Choose the subnetting scheme that will best support all networks (leave room for growth).
4. Assign network numbers.
5. Assign unique addresses to hosts.

Five Answers

- 1. 2^n = Amount of subnets.
- 2. 2^n – 2 = Amount of hosts per subnet.
- 3. 256 – Subnet mask = Base number.
- 4. Valid hosts are the numbers between the subnets, minus all 0's and all 1's.
- 5. Broadcast address is all 1's or the number before the next subnet.

Prefix Routing

- Means by which the Internet identifies the portion of the 32-bit TCP/IP address
  - /27 255.255.255.224
  - /26 255.255.255.192
  - /25 255.255.255.128
  - /24 255.255.255.0
  - /23 255.255.254.0

Discontiguous Addressing

- Two networks of the same classful networks are separated by a different network address.
- When using RIP or IGRP, you must use the default-router command.

Summarization

- Allows contiguous networks to be grouped together and advertised as one large network
- Also known as supernetting

Any Questions

MSTP